PHILIPPINE
JOURNAL
OF
SCIENCE

25
JULY-DEC
1924

THE PHILIPPINE JOURNAL OF SCIENCE

VOLUME 25

JULY TO DECEMBER, 1924

WITH 30 PLATES AND 32 TEXT FIGURES

MANILA
BUREAU OF PRINTING
1924

Gen. Vlahr.

CONTENTS

No. 1, July, 1924

[Issued August 8, 1924.]

No. 2, August, 1924

[Issued September 18, 1924.]

No. 3, September, 1924

[Issued October 4, 1924.]

VOL. 25, No. 1 JULY, 1924

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1924

202175

Manuscript intended for publication should be sent to the editor. One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Library, Bureau of Science, Manila, P. I.

The Journal is issued twelve times a year. The subscription price is 5 dollars, United States currency, per year. Single numbers, 50 cents each.

Subscriptions may be sent to the BUSINESS MANAGER, Philippine Journal of Science, Bureau of Science, Manila, P. I., or to any of the agents listed on the third page of this cover.

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 25 JULY, 1924 NO. 1

CONTRIBUTION TO THE SEROLOGY OF LEPROSY

By OTTO SCHÖBL[1] and M. BASACA

Of the Serum Laboratory, Bureau of Science, Manila

The serological investigations on leprosy so far have mainly been limited to the Wassermann reaction, and the frequency of positive results has been corroborated by many authors.

Although the high percentage of lepers that give positive Wassermann reaction seems to indicate that the infection by the lepra bacillus itself is capable of producing such physico-chemical changes in the blood as to give positive results, yet the possibility remains that some lepers may be and undoubtedly are afflicted with syphilis.

Recently, Goodpasture[2] reported the results of examinations of lepers by the complement-fixation method, using tuberculin as antigen. He found the serum of lepers to give inhibition of hæmolysis to a variable degree and claims that the inhibition of hæmolysis gradually diminished in lepers under chaulmoogra treatment. The high incidence of tuberculosis in lepers is known, and there is experimental evidence on hand to consider the beneficial therapeutic influence of chaulmoogra treatment upon tuberculous infection. It stands to reason, therefore, that neither the Wassermann reaction nor the tuberculin complement-fixation method could serve as a guide in detecting cases of leprosy in the stage when definite clinical manifestations are absent and bacteriologic diagnosis leaves us in the lurch.

[1] Member, Philippine Leprosy Research Board.

[2] Goodpasture, E. W., Philip. Journ. Sci. 22 (1923) 425.

In the absence of a specific reaction in leprosy, and considering the fact that the serum reactions recommended for diagnosis of syphilis, such as the precipitation reactions, appear simultaneously with the Wassermann reaction, we decided to probe the behavior in leprosy of a reaction which is not concomitant with the Wassermann or other serum reaction; that is, the globulin-precipitation reaction. This test, recommended by Klausner for diagnostic purposes, appears positive in the early stage of syphilis before the Wassermann reaction becomes positive and decreases gradually as the Wassermann reaction increases in strength. The nature of this reaction is believed to be a precipitation of globulin out of fresh patient's serum on dilution with distilled water. Upon standing or inactivation the serum loses the property of precipitation.

The technic, as employed in our tests, is very simple. A sufficient amount of blood was withdrawn from the cubital vein of the patient by means of a sterile syringe and placed in a test tube wetted with normal salt solution. As soon as the serum separated, it was pipetted off and placed in two narrow test tubes, 0.2 cubic centimeter each.

Distilled water [3] (0.6 cubic centimeter per tube) was then added carefully to avoid mixing the water with the serum. This was done by means of Wright's pipettes which were marked to contain 0.2 cubic centimeter and 0.6 cubic centimeter, respectively. One test tube was allowed to remain undisturbed, but the other was shaken thoroughly to mix the serum and the distilled water. Special care was taken that all of the sera tested were perfectly clear, and the test was performed not later than five hours after the blood was taken from thé patient.

The test tubes were allowed to stand at room temperature (average 27° to 28° C.) for at least two hours, when a preliminary reading was made. They were then placed in the refrigerator and read next morning. Positive reaction was discernible as a distinct ring at the surface of contact between the serum and the distilled water, while a diffuse cloudiness was perceptible in the tubes in which the serum and the distilled water were mixed. Upon final reading there was a distinct sediment at the bottom of the tube that showed a ring upon first reading. The sediment in the test tube containing serum

[3] The reaction of the distilled water used in these experiments averaged PH=6.6, or slightly less than—0.1 per cent phenolphthalein.

and distilled water thoroughly mixed was much more voluminous. This sediment, consisting of distinct flakes, was taken as a positive reaction and not the diffuse opalescence and the hazy ring; diffuse opalescence occurs in many human sera upon dilution with distilled water.

Rather than survey a long series of lepers, we selected limited groups for examination in order to gain information as to the behavior of the reaction in question in various stages and forms of leprosy. The duration of the disease is given as stated by the patients themselves and a liberal limit of error should be allowed in considering these data, because even a fairly intelligent patient may be unaware for a long time of the existence of the disease, as the initial symptoms are not very definite.[4]

The first group consisted of untreated bacteriologically positive and negative cases; the second group, treated bacteriologically positive and negative cases; the third group, treated microscopically negative anæsthetic cases; the fourth group, microscopically and clinically negative, cured lepers; the fifth, healthy nonlepers.

It can be seen from the results of these tests (Tables 1, 2, 3, 4, and 5) that all forms of leprosy, treated and untreated cases, cutaneous early and advanced cases, bacteriologically negative anæsthetic cases, as well as presumably cured lepers, gave positive results. Furthermore, it is evident that the intensity of the reaction is not dependent on the duration of the disease, although there seems to be some relation between the intensity of the reaction and the extent of the cutaneous lesions. In cured cases the reaction, although positive, was less pronounced than in the active cases.

A method and technic are given here of a serologic reaction that gave positive results in all cases of leprosy examined. Macular, nodular, anæsthetic, and mixed forms were tested, as well as cured lepers. The Wassermann test was performed on all of these cases, including twelve healthy nonlepers. In the healthy nonlepers the globulin-precipitation test was negative. The Wassermann test was positive in about 35 per cent of the lepers examined, while the globulin-precipitation test was positive in 100 per cent. One of the healthy nonlepers gave a positive Wassermann reaction (latent syphilis), becoming negative

[4] Cf. Gomez, L., The question of the initial lesion of leprosy, Journ. P. I. Med. Assoc. 3 (1923) 227–229.

after antisyphilitic treatment. The quantitative differences in the results of the tests, as indicated in Tables 1 to 5 by the number of plus signs, refer to the amount of precipitate that formed overnight with sera tested simultaneously. No control was used to compare with the quantitative differences in the strength of the reaction.

In order to establish a uniform and definite standard for gauging the strength of the reaction, we adopted the dilution method in our experiments. In a series of narrow test tubes a constant amount of fresh serum (0.2 cubic centimeter) was added to increasing amounts of distilled water, so that final dilutions resulted in the proportions 1 : 1, 1 : 2, 1 : 3, 1 : 4, and 1 : 5.

A number of healthy individuals, lepers, apparently cured lepers, and nonlepers suffering with tuberculosis, syphilis, yaws, and beriberi were subjected to the test. The results are evident from Tables 6, 7, 8, and 9.

If we examine these tables and draw a line through the 1 : 3 dilution column we can see that none of the plus signs cross this line in the tests that were performed with sera of healthy nonlepers. However, the sera obtained from cured lepers show a tendency, even though slight, to approach the normal line, particularly if we consider the 1 : 3 dilution column.

On the other hand, the results with sera from certain nonleprous patients deviate from the findings made in healthy persons in as much as positive precipitation occurred in dilutions lower than 1 : 4. These sera were obtained from cases of early and recrudescent syphilis, beriberi, and yaws.

The experiments given in Table 10 were arranged in order to obtain information as to the nature of the reaction. The precipitate that forms with positive sera behaves in many respects like globulin. It is insoluble in distilled water but soluble in normal salt solution and in concentrated solution of sodium chloride.

Further information was sought as to the influence temperature has upon the reaction. It has been noticed that the sera tabulated in Tables 1 to 5, when retested after inactivation for thirty minutes at 56° C., gave negative results, with the exception of a few strongly reacting sera, some of which showed a faint precipitate after inactivation. It shows that the inactivation decreased the reactivity of the sera.

The influence of temperature on the course of the reaction proper is evident from the results of experiments tabulated in

Tables 10 and 11. It shows that the precipitation is promoted by lower temperature and does not occur at higher temperature in every case. The serum, however, can be preserved at low temperature for at least twenty-four hours without losing its reactivity completely.

In the experiment given in Table 10 there was no difference in the amount and character of the precipitate, whether the serum-distilled water mixture was incubated at 37° C., at room temperature (average, 27° to 28° C.) preliminary to storing in the ice chest (9° C.), or placed immediately in the ice chest. On the other hand, the serum-water mixture allowed to stand at room temperature or at 37° C. did not precipitate at all in some cases. Fresh sera allowed to stand in the ice chest overnight and retested twenty-four hours later gave positive results, one of them showing a slight decrease in titer (Table 11).

The condition found in the sera of lepers and certain other patients may be conceived as an upset balance between salts and globulin, possibly euglobulin. Therefore, it has not the significance of a strictly specific immune reaction but, owing to its apparent constancy in leprosy, may prove to be of help as an adjuvant test. It is, moreover, a promising hint to those who may consider a thorough investigation of blood chemistry in leprosy.

Thanks are due to the chief of San Lazaro Hospital and to the staff of the leper department for their courtesy in supplying the necessary material.

The following symbols are used in Tables 1 to 11: —, negative; +, positive; ±, faint reaction; O, not examined.

TABLE 1.—*Results of globulin-precipitation and Wassermann tests in untreated microscopically positive and negative cases.*

[Dilution, 1 : 3 water.]

Name.	Age.	Duration of sickness.		Globulin test.		Wassermann reaction.	Remarks.
				Ring.	Precipitate.		
	Yrs.	*Yrs.*	*mos.*				
F. C.	16	0	1	+	+	±	Macular; positive.
J. A.	60	7	0	+++	+++	—	Macular; tubercular; positive.
E. M.	18	0	5	++	++	—	Do.
R. U.	22	2	0	+	+	—	Macular; positive.
B. D.	48	2	0	+	+	—	Paresthesia; tique convulsive; negative.

TABLE 2.—*Results of globulin-precipitation and Wassermann tests in cutaneous form of leprosy in treated microscopically positive and negative cases.*

[Dilution, 1 : 3 water.]

Name.	Duration of sickness.		Globulin test.		Wassermann reaction.	Remarks.
			Ring.	Precipitate.		
	Yrs.	*mos.*				
B. T	1	6	±	±	—	Tubercular; positive.
A. S	12	4	±	+	±	Do.
G	1	6	+	++	±	Macular; tubercular; positive.
E. B	1	6	+	+	—	Tubercular; positive.
F. V	1	2	++	++	—	Macular; tubercular; positive.
R. M	2	8	+	++	+	Mixed; positive.
C. M	7	6	+	++	±	Do.
J. M	3	0	±	+	—	Macular; positive.
S. C	1	6	±	+	—	Macular; tubercular; positive.
A. V	2	6	+	+++	+	Do.
J. R	0	8	+	++	±	Do.
P. E	4		++	++	—	Macular; negative.
J. M	0	9	±	+	—	Do.
R. R	0	10	+	+	—	Do.

TABLE 3.—*Results of globulin-precipitation and Wassermann tests in treated microscopically negative anæsthetic cases of leprosy.*

[Dilution, 1 : 3 water.]

Name.	Age.	Duration of sickness.		Globulin test.		Wassermann reaction.
				Ring.	Precipitate.	
	Yrs.	*Yrs.*	*mos.*			
B. L	15	3	4	++	++	—
M. R	15	2	3	++	++	—
P. C	55	2	0	++	++	++++
P. E	30	16	0	+	+	—
F. G	23	3	0	++	++	—

TABLE 4.—*Results of globulin-precipitation and Wassermann tests in microscopically and clinically negative presumably cured lepers.*

[Dilution, 1 : 3 water.]

Name.	Age.	Duration of sickness.		Negative.		Globulin test.		Wassermann reaction.
						Ring.	Precipitate.	
	Yrs.	*Yrs.*	*mos.*	*Yrs.*	*mos.*			
I. L	15	(?)		1	0	—	±	±
J. F	21	7	0	3	0	—	±	±
A. R. F	32	1	6	0	6	+	+	—
P. S	34	2	0	0	7	+	+	—
A. M	31	2	0	0	7	+	+	±

TABLE 5.—*Results of globulin-precipitation and Wassermann tests in normal nonlepers.*

[Dilution, 1 : 3 water.]

Name.	Age.	Globulin test.		Wassermann reaction.	Remarks.
		Ring.	Precipitate.		
	Yrs.				
C. C	22	—	—	—	
F. M	22	—	—	—	
V. B	18	—	—	—	
F. D	18	—	—	—	
F. R	19	—	—	—	
P. C	23	—	—	—	
F. C	24	—	—	++++	Latent syphilis.
A. C	21	—	—	—	
B. A	21	—	—	—	
L. D	17	—	—	—	
A. I	(?)	—	—	—	
J. E	18	—	—	—	

TABLE 6.—*Results of titration of fresh sera from cured lepers.*

[0.2 cubic centimeter of serum mixed with increasing amount of water.]

Name.	Age.	Duration of sickness.		Negative.		Globulin precipitation, water in cubic centimeters.				Wassermann reaction.
						0.4	0.6	0.8	1.0	
	Yrs.	*Yrs.*	*mos.*	*Yrs.*	*mos.*					
P. R	47	(?)		4	0	—	±	+	+	—
C. M	20	2	6	1	0	±	+	+	+	—
E. E	45	8	0	4	0	±	+	+	+	—
M. S	53	11	0	8	0	±	+	+	+	—
J. C	48	5	0	1	6	—	±	+	+	—
A. G	33	3	0	2	0	—	±	+	+	—

TABLE 7.—*Results of titration of fresh sera from active cases.*

[0.2 cubic centimeter of serum mixed with increasing amount of water.]

Name.	Globulin precipitation, water in cubic centimeters.			
	0.4	0.6	0.8	1.0
M. S	—	+	+	+
F. R	±	+	+	+
S. C	+	+	+	+
J. S	±	+	+	+
B. P	—	+	+	+

TABLE 8.—*Results of titration of fresh sera from healthy nonlepers.*

[0.2 cubic centimeter of serum mixed with increasing amount of water.]

Name.	Globulin precipitation, water in cubic centimeters.			
	0.4	0.6	0.8	1.0
R. R	—	—	±	+
D. P. A	—	—	—	±
D. J. B	—	—	—	—
M. T	—	—	—	—
C. C	—	—	—	—
V. B	—	—	+	+
F. M	—	—	—	—

TABLE 9.—*Results of titration of fresh sera from nonleprous patients.*

[0.2 cubic centimeter of serum mixed with increasing amount of water.]

Name.	Globulin precipitation, water in cubic centimeters.				Wassermann reaction.	Remarks.
	0.4	0.6	0.8	1.0		
R. M	—	±	+	+	—	Beriberi.
M. R	±	+	+	+		Yaws, latent.
J. A	—	—	O	O		Tubercular, afebrile.
Cyr	—	—	+	+		Do.
G. S	—	—	O	O	+++	Syphilis, latent.
M. E	—	+	+	+	++++	Syphilis, early.
B. B	—	—	±	+	++	Syphilis, latent.
R. T	—	±	+	+	+++	Do.
F. D	—	±	+	+	+	Suspected syphilis.

TABLE 10.—*Influence of temperature upon the globulin precipitation test.*

Amount of fresh serum.	Incubated at—		Ice box, 9° C.	Result with sera of—			
	Room temperature.	37° C.		S. R.	S. C.	J. S.	B. P.
cc.	*Hrs.*	*Hrs.*	*Hrs.*				
0.2	2	0	12	+	+	+	+
0.2	0	2	12	+	O	O	O
0.2	0	18	0	—	+	—	—
0.2	18	0	0	—	+	+	+
0.2	0	0	18	+	+	+	+

TABLE 11.—*Keeping quality of fresh sera at low temperature.*

FRESH SERUM.

Name.	Form of leprosy.	Duration of sickness.	Dilutions.					
			1:1	1:2	1:3	1:4	1:5	1:6
		Yrs.						
M. S.	Mixed	10	—	—	+	+	+	+
F. R.	do.	1	—	±	+	+	+	+

SERUM 24 HOURS OLD, 9° C.

M. S.	Mixed	10	—	—	+	+	+	+
F. R.	do.	1	—	—	+	+	+	+

TERTIARY PALEOGEOGRAPHY OF THE PHILIPPINES

By Roy E. Dickerson

Honorary Curator, Department of Paleontology, California Academy of Sciences, San Francisco

FOUR PLATES AND TWELVE TEXT FIGURES

INTRODUCTION

Geology and that particular phase of biology known as biogeography, which deals with the distribution of life forms, are connected through paleogeography. Paleogeography seeks to delimit the former shore lines of islands and continents and to interpret, by indirect evidence, information concerning the topography of these land masses. The changes that cause the shifting patterns, first uniting and then disconnecting portions of land on the outer edge of the continental platforms, vastly influenced life upon land in such regions. These changes during the Tertiary in the Philippines are very notable and, in order to grasp the fundamentals of the distribution of life in the Philippines, some idea of the Philippine Islands of the past is necessary. May the broad outlines here sketched prove useful to workers in both geology and biology.

PALEOGEOGRAPHY

The geological record in the Philippines is unusually fragmentary when comparison is made with the neighboring island Borneo. As yet no Cretaceous, Eocene, or Oligocene rocks have been recognized in the Philippines. Only cherts of questionable Jurassic age, Miocene sandstones, limestones and shales, Pliocene coralline limestone and rocks largely composed of detrital material from coral reefs and from igneous flows of andesite or basalt, and Pleistocene coralline limestone and sands record the history of ancient life in the Philippines.

THE PHILIPPINES DURING EARLY TERTIARY TIME

The lack of any early Tertiary sedimentary record leaves this important portion of the time in which modern life had its beginning largely blank. Our information concerning conditions previous to the Miocene depends upon inferences derived from a

study of the character of Miocene sediments and from certain indirect paleontological evidence concerning Formosan botanical affinities. The sedimentary rocks of Vigo-Miocene age, which are characterized by the presence of the finger posts of the East Indian Miocene, *Vicarya callosa* Jenkins and various species of *Lepidocyclina* and associated Foraminifera at various horizons, contain detrital material which has obviously been obtained through erosion of the basement complex of cherts, schists, serpentine, and diorite. At places, the materials contained in the Vigo sandstone is very coarse, and conglomerates occur locally in Bondoc Peninsula, southern Luzon, and on a great scale in northwestern Leyte, east of Tabubunga Barrio, where they in part closely resemble characteristic desert fanglomerates.

Again, in Panay, the thick lower portion of this group is composed of massive conglomerates, evidently derived from a source close at hand. Coarse materials also compose portions of the Vigo strata west of Baguio and in Cagayan Valley, northern Luzon, and in Mindanao as well. Such materials could not have been transported great distances, thus evidencing a land mass composed of the rocks of the basement complex. During early Vigo time the sedimentary record of Formosa is in part the same as that of the Philippines. Eocene has been recently discovered in the so-called clay slate strata of this island. Cretaceous has not been reported, but one must remember that this large island, like the Philippines, has not been studied in detail. Paleozoic rocks occur in the central part of Formosa, according to Dr. S. Nakamura, of the Imperial University of Kyoto. As far as our present knowledge goes, all of Tertiary time previous to the Vigo-Miocene may be recorded by the unconformity between the Vigo and the basement-complex rocks. In other words, Formosa and the Philippines may have been a united land mass (fig. 1).

The other evidence pointing in the same direction is supplied by Elmer D. Merrill and by Warren D. Smith.[1] At Sagada, in northern Luzon, at an elevation of 1,500 meters, Father Staunton discovered a fossil flora locality, and Doctor Smith collected the fossils which were determined by Elmer D. Merrill. Among them were characteristic dipterocarps at present living only at sea level or at elevations below 600 meters. Now, this flora is stratigraphically connected with Malumbang-Pliocene coralline

[1] Smith, W. D., Notes on a geologic reconnaissance of Mountain Province, Luzon, P. I., Philip. Journ. Sci. § A 10 (1915) 195–197.

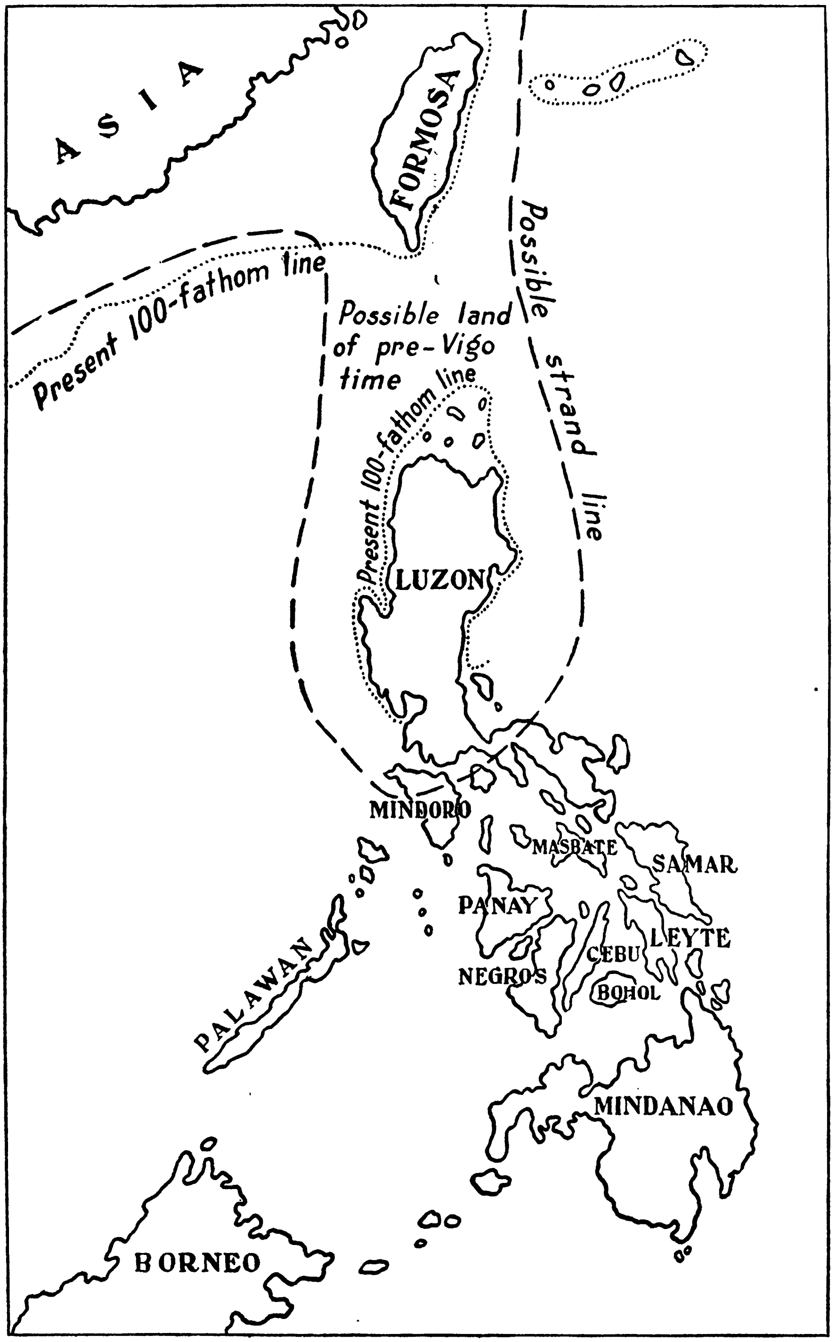


FIG. 1. The Philippine Islands, showing hypothetic connections during pre-Vigo time.

limestone at this place. The point of this matter is that no dipterocarps occur in the Formosan flora of to-day. According to Merrill, the climate and soil are not unsuitable in Formosa, and he can see no reason for their absence except its long separation from the Philippines. The absence of the dipterocarps from Formosa leads, then, to the conclusion that that island was not connected with Luzon during the Pliocene. Unfortunately, no decisive paleobotanical evidence from Formosa is at hand; but the study of the distribution of marine sediments of Vigo age, both in Formosa and in the Batanes and Luzon, indicates with great clearness that much of the present site of both Formosa and northern Luzon, as well as the intervening Batanes region, was covered by waters of the Vigo-Miocene sea. Dr. Albert W. C. T. Herre's recent investigations upon the fresh-water fishes of the Philippines shows that no forms having affinities with Formosan fresh-water fishes are known. All Philippine true fresh-water fishes are allied to Bornean forms. This evidence is in entire accord with the known geological data. Hence, a connection between Luzon and Formosa at this stage is highly improbable.

At various places erosional contacts between the Vigo and the basement complex indicate that a great period of subaërial erosion preceded the deposition of marine Vigo-Miocene. At this stage it is highly probable that Formosa and northern Luzon were firmly connected, and it is even probable that the plants common to these two islands spread southward from Formosa at this time. Definite evidence of the precise stage at which this floral occupation occurred is lacking, but it is the writer's opinion that it was during the interval between the Oligocene and the Miocene; that is, Ep-Oligocene time or early Miocene. This opinion is based upon the probable rate of evolution of plants. It seems highly improbable that about forty present-day plants common to Formosa and northern Luzon could have persisted in both Formosa and Luzon for a greater period without specific change. This idea is tentatively set forth by the accompanying map of pre-Vigo time (fig. 1). Just how far to the south this probable pre-Vigo land mass extended is problematical, as the present-day, high-altitude flora does not persist farther south than the present high mountains of northern Luzon, and other guides are lacking, as probably all of this southern area was under the sea during a portion of the geologic time after the beginning of the Vigo.

THE PHILIPPINES DURING VIGO-MIOCENE TIME

As indicated above, the Vigo group of Miocene age, which is characterized faunally by the presence of *Lepidocyclina* and the gastropod *Vicarya callosa,* was deposited unconformably upon the basement-complex rocks. As was noted above, moreover, in certain localities the Vigo sedimentaries are conglomerates and coarse-grained sandstones derived from the basement-complex rocks, in marked contrast with great thicknesses of shale and limestone which indicate accumulation in deeper waters. When the distribution of these two types of rock shall have been studied some conclusions will be possible. The basal member of the Vigo group in Leyte near Tabubunga on the northwestern coast is a thick fanglomerate which very evidently was deposited either as land-laid material or close to the shore, since some of the bowlders are more than a meter thick. The prevailing sediments in Cebu, on the other hand, probably not very far above the base, are coal seams associated with *Lepidocyclina* limestones which are in turn overlain by fine-grained shales. While the coal may be regarded as lagoon or shore-marsh deposits, the *Lepidocyclina* limestone indicates deposition in water decidedly offshore; that is, not strictly littoral deposits. Samar, likewise, is characterized on the whole by shales and *Lepidocyclina* limestone. *Lepidocyclina* limestone is found above the coal on Batan Island off the east coast of Camarines Peninsula. West of Camarines Peninsula is Bondoc Peninsula, the type locality of the Vigo group. Upon this peninsula the Vigo is, in general, represented by shales, sediments probably deposited in the deeper waters of a Vigo inland sea. Farther to the north, on Polillo Island, coal of commercial value is reported by W. D. Smith, which fact indicates a shore-line condition. The connection between this island and the central highland of northern Luzon is probably broken by relatively recent movements along the northern end of the Taal fault which now marks the continental shelf along the steep eastern coast of northern Luzon. This great fault extends from the west side of Palawan, at sea, northeasterly across central Luzon. In all probability, Vigo sediments have been dropped downward upon the eastern side of the Taal fault, while the older basement-complex rocks have been upthrust to form the steep-cliffed, east-coast mountains, the wild Sierra Madre Range. The Vigo sedimentaries of Cagayan Valley are in general coarse-grained sandstones and lignites and apparently represent shallow-water deposition in a marked geosynclinal trough which was

bordered by land on either side. On the northwest coast of Luzon the great section of the Vigo group exposed along the Naguilian Road west of Baguio evidences littoral deposition.

Now, this distribution of sediments as briefly outlined above indicates that an elongate Palawan-like island existed which stretched from the eastern coast of Mindanao through central Leyte, through Camarines Peninsula, across the embayment on the eastern side of Polillo, northward on the east side of northern Luzon (fig. 2). In all probability, during Vigo time there was a good-sized island mass in Abra Province and in western Kalinga and Apayao Subprovinces of the Mountain Province. The great amount of coarse sediments exposed along the Naguilian Road west of Baguio, Benguet Subprovince, indicates that land was close at hand. Whether in addition to this smaller island through north-central Luzon there was another, 64 to 80 kilometers west of northern Luzon, in the China Sea site of to-day, is hypothetical; but the great thickness of the Vigo group and the coarse character of these sediments indicate a neighboring land mass of larger size than the narrow island or peninsula which separated the Cagayan Vigo embayment from the basin of deposition west of Baguio. The ocean contours delimiting the west side of northern Luzon might well be interpreted as indicating a continuation of the great Formosa fault which delimits this island on its eastern side, and movements along such a fault may have carried this western island of Vigo time beneath the sea. The great amount of coarse sediments described by Abella in the basal Tertiary beds in Iloilo Province, Panay, indicates that the material of Vigo-Miocene age was derived from a considerable land mass entirely or in part to the west of Panay Island of to-day. A study of the orientation of Tablas Island and the western coast of Panay lends some support to this hypothesis, and it is possible that such an older land mass is now covered by the waters of Cuyo East Pass. In other words, a dropped block is now present west of Panay. Connections to the south from Mindanao to Celebes during Vigo-Miocene are entirely probable and, from the biologic evidence, Celebes may have been connected either directly or indirectly by a stepping-stone bridge or a more solid structure with this elongate north-stretching island. Information concerning paleogeographic details of the Philippine Archipelago during the Vigo-Miocene are distinctly hazy, but we may at least conclude from all the evidence at hand that an archipelagic condition prevailed during those times.

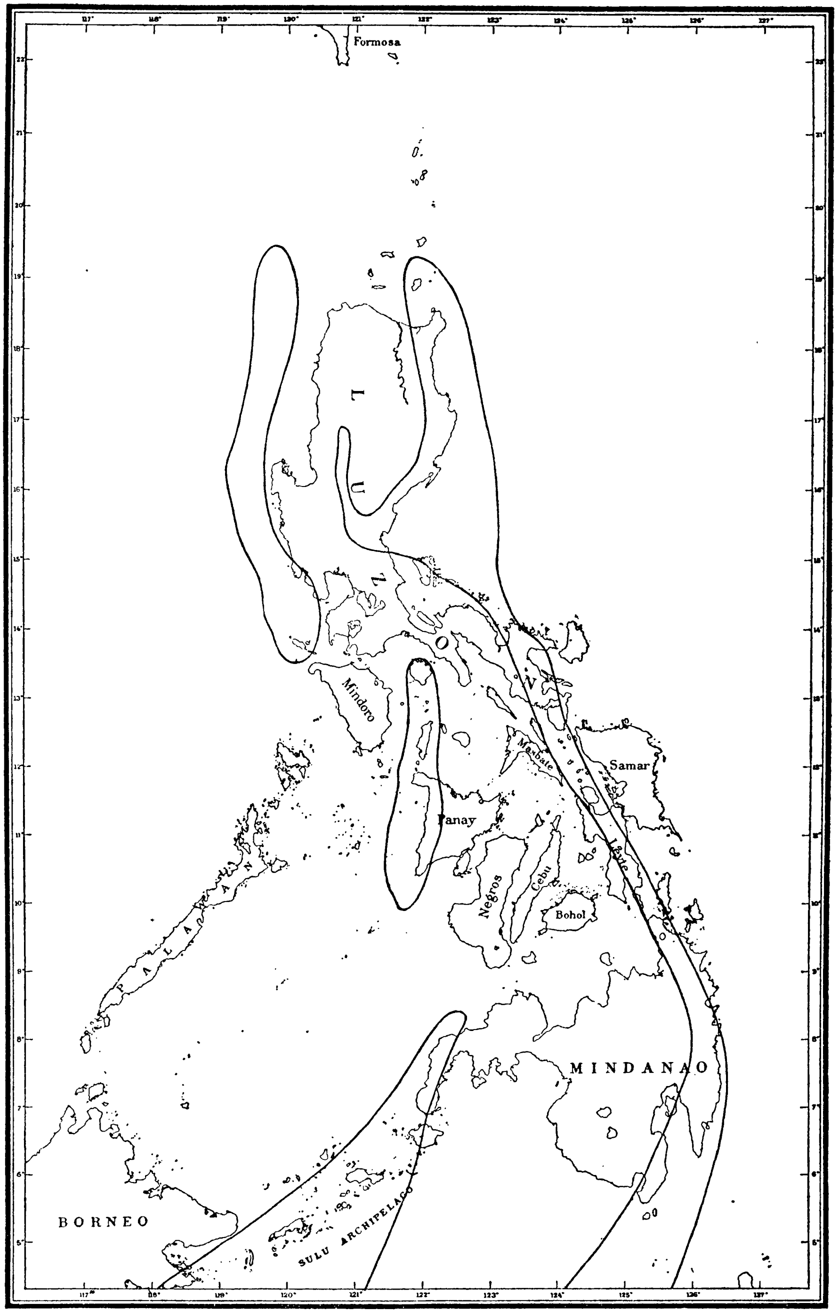


FIG. 2. Probable islands in the Philippine area during Vigo-Miocene time.

SOME POSSIBLE PLIOCENE PHILIPPINE ISLANDS

As incidentally indicated in this discussion of the Vigo-Miocene the sediments were very evidently derived from erosion of an older land mass composed of diorites, slates, schists, and cherts; but a study of the Pliocene beds as exposed in the Philippines indicates that the dominant process during this stage was the accumulation of organic sediments and volcanics. The writer recognizes that this is not wholly true, as Schenck and Moody have demonstrated the presence of bowlders of *Lepidocyclina* limestone of Vigo-Miocene age in Pliocene strata of probable Malumbang-Pliocene age. Such evidence indicates that the Vigo sediments have been consolidated, faulted, and eroded in part to form the sediments of the Pliocene sea. There is a remarkably small amount of quartzitic or dioritic rock fragments in the sandstones of Pliocene age. The abundance of andesitic bowlders and fragments of coral rocks containing species closely related to or identical with those living in the Philippine waters of the present day, is a notable character in the Pliocene sediments about Baguio, Mountain Province, northern Luzon. However, Smith reports much sandstone of upper Pliocene age associated with coralline limestone in his Banisilan beds in the region north of Cotabato River. In most of the larger islands of the Philippine Archipelago, coralline limestone of Pliocene age is common, and the corals composing them are typical of the fringing reefs now bordering the shore line of the islands of this group to-day. It is well known that these reef corals are limited to waters varying from sea level to a maximum of about 70 meters in depth. Such widespread occurrence of coralline limestone, which indicates such shallow deposition, evidences again an archipelagic condition of the Philippines during their deposition. The location of land masses during this stage is indefinite and vague. A portion of the present site of Samar was probably land during Malumbang time, as the Malumbang on this island is derived directly through erosion from previously formed *Lepidocyclina* limestone of Vigo-Miocene age. The present site of Agusan Valley in Mindanao was occupied by the shallow waters of a Pliocene sea, as is indicated by the presence of fossils at several points in Agusan, Saug, and Tagum Valleys. These sediments are all of the inshore type, and an island occupying the eastern side of Mindanao of to-day and, possibly, extending several miles farther east of the present shore line, seems probable. A study of Malumbang-Pliocene in the northern peninsula of Leyte and

the southern peninsula of the same island indicates that most of this island was covered by shallow waters at this stage. Most of Bohol is composed of Malumbang-Pliocene limestone, and the presence of the same rock in Cebu is notable. North of Cebu, apparently the entire island of Masbate of to-day was covered by a shallow Pliocene sea, and a striking unconformity on Ticao Island between these rocks and the rocks of the basement complex was found by Dr. A. N. Kryshtafovich. The wide extent of Malumbang limestone in Bondoc Peninsula, Luzon, as indicated by Pratt and Smith, demonstrates that this site was likewise beneath the waters of the sea at this stage. Owing to the great amount of volcanic rock and rocks of the basement complex in Camarines Peninsula, but little is known concerning the presence of marine sediments at this stage; and, although lack of evidence is no adequate proof, it seems to the writer that the Pliocene island of Samar may have extended northward covering a portion of this peninsula. In northern Luzon, however, the evidence is far clearer, and island masses or a single large irregular island covered the present site of northern Luzon. As was indicated briefly in the discussion of the distribution of the dipterocarps above, landlaid tuffs found in Sagada in close association with coralline limestone demonstrate the presence of adjacent land. In Cagayan Valley Doctor Kryshtafovich found a similar fossil dipterocarp flora associated with Malumbang strata, and upon these two bases the presence of a large irregular island or islands in this region has been indicated.

Rocks of Malumbang-Pliocene age occur in Negros and are present in great amount in the central portion of Panay. In southern Mindoro, rocks referred to this age were discovered by Moody and Kryshtafovich. Coralline limestone is reported at a few other places upon Palawan. Such evidence indicates that in the Pliocene a Philippine archipelago existed with, in all probability, the same elongate series of islands or a single irregular island as probably existed in Vigo-Miocene upon the eastern side of this group. Certain other well-recognized island masses existed in northern Luzon, and it is quite probable that a rather large island or islands occupied portions of the present site of Panay and Negros. It is exceedingly important to grasp the significance of this continued insular condition during the Miocene and Pliocene periods and the persistence of the elongate island on the eastern side of the Philippines when the questions of the distribution of plant and animal life are considered (see fig.

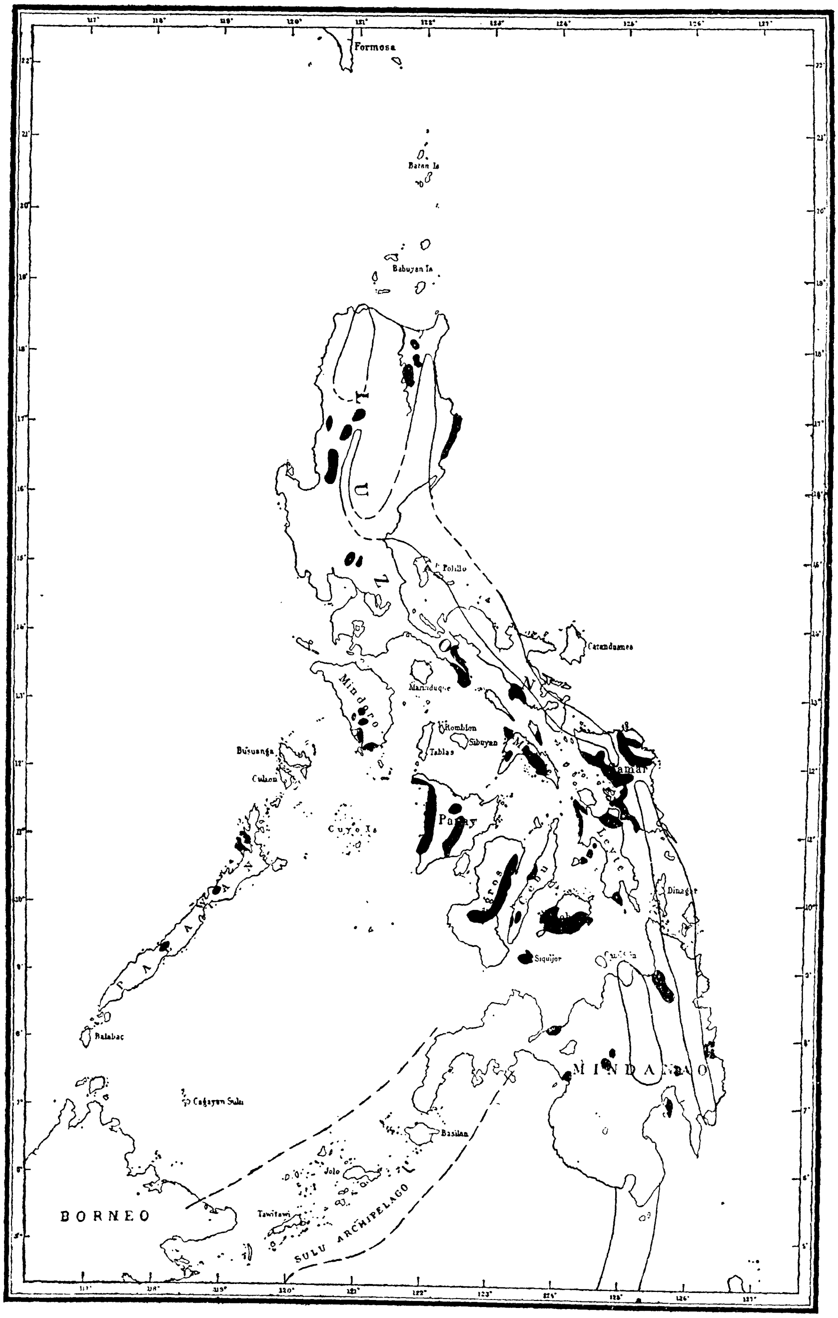


FIG. 3. Some probable Pliocene islands of the Philippine area. Shading represents marine Pliocene rocks.

3). The apparent scarcity of large mammalian remains in the Philippines is possibly a reflection of this persistent insular condition. The possibility that Mindanao was connected through the Sulu bridge with Borneo during the Pliocene is suggested by the reported discovery in northern Mindanao of *Stegodon,* a genus of elephants that was exceedingly common in the Pliocene of India and other portions of Asia. However, there is some doubt concerning the authenticity of this occurrence in Mindanao, and we are unable to assert with positiveness that the Sulu bridge was a stable structure during that time. The wide extent of shallow-water deposits of Pliocene age in the Philippines indicates in all probability that the submarine topography of that period was quite different from the complicated topography of the ocean bottom of the present day.

Other, broader considerations, which will be discussed in connection with the subject of hydrography, indicate that the present sea bottom of the Philippines with the sharp contrast between elevated islands and great deeps, such as the Sulu and Mindanao deeps, has been formed since the Pliocene.

PLEISTOCENE PHILIPPINE ISLANDS

Much of interest to the biologist will be found in the consideration of the distribution of Pleistocene sediments in the Philippines. In the discussion given above, much of the information of interest to geologists and paleontologists is vague and indefinite, but there are certain general conclusions which can be drawn upon the basis of our present knowledge. Our knowledge of the Pleistocene is likewise very fragmentary. Mr. Graham B. Moody, who has made an excellent reconnaissance of Mindanao, outlined some of the complexities that occurred during this period. His statement in a letter concerning Pleistocene conditions is as follows:

> Along the north coast of Mindanao between Iligan and Cagayan, there are seven wave-cut terraces in the hills to an estimated elevation of 360 meters. The north edge of Camiguin Island shows excellent benches. There are well-marked, wave-cut benches in the hills south of Cotabato to an estimated elevation of 300 meters. Musuan Volcano, south of Mailag, Bukidnon Subprovince, has a terrace cut practically around it at an elevation of about 400 meters. The hills west of Malaybalay, Bukidnon, exhibit terraces at elevations well over 600 meters, but these may be due to successive flows of lava producing a bench effect. Malitabug River Valley at Banisilan, Cotabato, has five distinct stream terraces on each side, Banisilan being located on the oldest terrace at about 375 meters elevation, while the present elevation of the river is about 200 meters. [See Plate 1, fig. 1.]

A coralline limestone containing many living species of coral, and lying horizontally or only slightly inclined, is widely distributed throughout certain parts of Mindanao and, where in determinable relation with other rocks, always overlies them. This coralline limestone is found on islands in Davao Gulf; in Saug River, Davao Province; at an elevation of about 210 meters on the ridge between Saug and Agusan Rivers; at elevations of 150 meters in tributaries to Agusan River; throughout the floor of Cotabato Valley; and in the hills south of Cotabato at an estimated elevation of 300 meters. This limestone is probably Pleistocene in age.

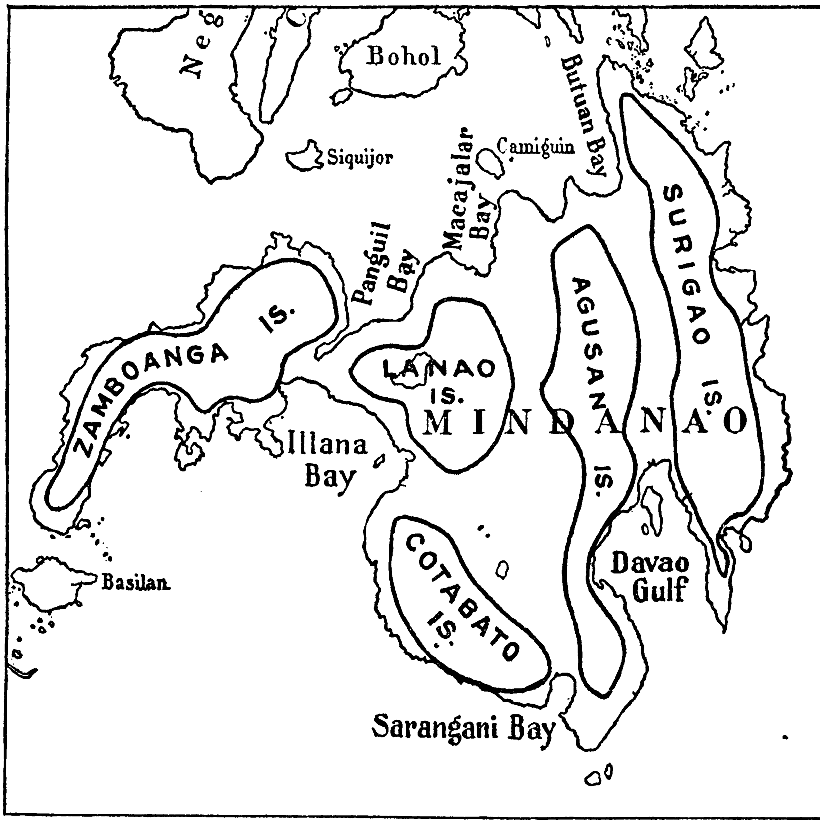


FIG. 4. Mindanao islands during early or middle Pleistocene.

The data noted above suggest that Mindanao was devided into five smaller islands in early Pleistocene time. There were probably water connections as follows: Butuan Bay to Davao Gulf, Macajalar Bay at Cagayan de Misamis through Bukidnon Province to Illana Bay at Cotabato with probably a connection to Sarangani Bay, and from Panguil Bay to Illana Bay. [See fig. 4.] Pulangi River rises in the northeasterly part of Bukidnon Province, flows southerly through the mountains for about seventy-two kilometers, then turns abruptly to the west and debouches

upon the Bukidnon Plain to flow again southerly for about seventy-two kilometers to Kabakan, Cotabato Province, at which point it becomes Cotabato River and meanders westerly through Cotabato Valley to Illana Bay. The course of Pulangi River indicates, as first suggested by Doctor Dickerson, that this river emptied into the Cotabato-Cagayan Strait at about Lumbayo, Bukidnon, in early Pleistocene time. The gulf floor was then elevated to form the Bukidnon Plateau and Pulangi River then intrenched itself in a southerly course, emptying into Cotabato Gulf of later Pleistocene time somewhere near Kabakan. The floor of Cotabato Gulf then slowly emerged to form Cotabato Valley, and Pulangi River found its way westerly to Illana Bay through Cotabato Valley. The other northerly tributaries of Cotabato River; namely Libungan, Malitabug, and Maridagao Rivers exhibit analogous drainage histories. Some of the tributaries of Agusan River north of Talacogan flow in a southerly direction until they meet Agusan River, when the direction of flow changes to north. This suggests that these rivers formed their channels and flowed into the Davao-Butuan Strait in early Pleistocene time and that they still indicate their original drainage although subsequent uplift caused the chief drainage to be to the north. The Post-Pliocene uplift of Mindanao seems to have taken place in about seven well-marked stages and the total elevation has been at least 360 meters.

The accompanying map shows the approximate outlines of the five major Pleistocene islands of Mindanao (Pleistocene-Mindanao) which are for convenience given names. [See fig. 4.] Although this map does not demonstrate clearly the fact, these Pleistocene-Mindanao islands coincide closely with the present topographic high places of Mindanao; the present low places correspond to the early-Pleistocene seas and straits. This division of Mindanao into five major early-Pleistocene islands is based upon the distribution of the Pleistocene coralline limestone and wave-cut terraces and is a tentative separation. Further investigation will probably show that Pleistocene-Mindanao islands Zamboanga, Surigao, and Agusan were really two islands each; but present evidence is not sufficiently definite to subdivide them. Cotabato Island was undoubtedly not a single island, but a group of small islands. It will be noted that the five major Pleistocene-Mindanao islands form an insular group not much dissimilar to the present Visayan group.

Four of the most striking topographic features of Mindanao are: (a) Agusan Valley and its huge swamp, (b) Cotabato Valley and its vast marsh areas, (c) Bukidnon Plateau, and (d) Lake Lanao. These phenomena have been largely affected by post-Pliocene activity. The Agusan swamp is due to sinking along a fault zone, which is still a zone of maximum tectonic activity. Cotabato Valley is the floor of a gulf elevated in post-Pliocene time, with low spots covered with water. Bukidnon Plateau was the northerly extension of Cotabato Gulf and was elevated before the present Cotabato Valley was formed; lava flowed over the northern part of Bukidnon Plateau subsequent to or during its elevation. Lake Lanao, elevation 660 meters, represents the blocking up of a large Pleistocene valley by repeated flows of igneous rock during the period of Pleistocene elevation.

Those familiar with Philippine geology may question the use of a coralline limestone as an horizon marker and they may have good reason for their

doubt. Corals now growing along the shores of the Philippine Islands, corals collected from the Pleistocene limestone, and corals collected from the Malumbang limestone are, so far as is known, generically and specifically the same; this also holds true for the pelecypods and gastropods. If a coralline limestone lies horizontally, or nearly so, it is assigned to the Pleistocene. In some places, for example, the northwest coast of Leyte, horizontal coralline limestone lies across the truncated edge of upturned limestone; here the upper limestone is called Pleistocene and the lower limestone Pliocene (Malumbang). Separation of Pleistocene limestone from Pliocene limestone can be, under present limitations of collected data, only fairly accurate. It is to be hoped that some determinative characteristic of one of these limestones may be worked out.

When one remembers that the Pleistocene period was not simple, but was complicated by an alternation of warm and cold stages, even greater complications were probably present than Mr. Moody's interesting discussion indicates.

North of Mindanao benches, about 120 or 150 meters elevation, are described by several observers in Bohol, Leyte, and Samar. The abundance of coralline limestone and marl and a well-marked marine terrace over the southern half of Bohol indicate that but little of Bohol was above sea level during the Pleistocene. Likewise, very notable terraces are found in the neighboring island Leyte in the northwest peninsula, where they have been studied with some care. These terraces are particularly well exposed in the area immediately south of Rabin Point, the northwest cape of Leyte. Here there are at least four terraces at approximate elevations of 4.5, 30, 60, and 105 to 120 meters above the present sea level. The Pleistocene coralline limestone is apparently thick in this area, and judging from a contact about 6 kilometers south of the point at Daja Bay the unconformity between this Pleistocene coralline limestone and the steep-dipping beds of Vigo age can be well seen in the north headland of Daja Bay. An estimated thickness of coralline limestone based upon these data and the elevations of some of the terraces is between 60 and 90 meters. When one traverses the terraces in the vicinity of Jubay, a small barrio on the west side of this peninsula in the vicinity of Rabin Point, nothing but coralline limestone is seen. The 30-meter and 60-meter terraces appear to persist over the whole southwest side of Leyte. Thus, on the north headland of Tabango Bay, the 60-meter terrace is particularly well pronounced. The 30-meter and 60-meter terraces occur likewise in the vicinity of Palompon and are probably present southeast of Maasin on the peninsula south of Baybay. On this southern

peninsula of Leyte there is marked evidence of a still higher terrace at 120 to 150 meters elevation. The changes in level of the strand line in Pleistocene time thus indicated were probably even more complicated. In certain regions in Leyte there are distinct evidences of recent depressions. In the vicinity of San Isidro and Arevalo Bays on the west side of the northern peninsula excellent proof of depression is presented. Along the trail between Tabango and San Isidro beautiful views of these small bays are seen. The picturesque gateways of these bays, composed of massive, resistant rocks of the Malumbang and Canguinsa formations, are striking features. Near Arevalo Bay these rocks dip west at an angle of 20°. From the divide ridge between Tabango and Arevalo Bays there appears to be a general even surface which truncates the hills at an elevation of about 150 meters, probably an old marine terrace. This surface was developed at or above sea level, as the drainage of the present clearly had an antecedent history which is evidenced by the water gaps of seaward-dipping sandstones and marls and coralline limestone of the Malumbang formation of Putingbato Ridge as well as the tuffaceous member of the Vigo group. Where the rocks traversed by the stream were resistant the former stream valleys were narrow, and the headlands of the bays of the present time were formed in this manner. Such topography and stream development indicate that the first streams were developed upon a broad, nearly level surface, gently sloping to the sea, and that they cut across the country on the surface of a probable Pleistocene age. Successive uplifts of Leyte and the vicinity followed; as a result of this movement, the streams were rejuvenated and they proceeded to cut cañons across the hard resistant rock, the more resistant Malumbang and tuffaceous member bordering the present coast beneath the soft Pleistocene surface, and rapidly widened their cañons in the soft shales of the Vigo group. Later, depressions occurred and the Visayan Sea invaded the land occupying the narrows of the former cañons and portions of the widened valleys within. The streams with their heavy loads of silt, the reef corals, and the mangroves are aiding the land to recover its own. Such events have resulted in the production of the surpassing beauty of Arevalo Bay with its fine ramparts of white limestone and sandstone guarding its entrance and the surrounding grass-covered hills and green-bordered shore of mangroves.

Similar history with similar complications has recently been reported by Schenck.[2] The conditions on the east side of Samar in the vicinity of Taft and Dolores are described by him as follows:

Embayed and irregular shore lines and the drowning of Malinao River are evidences of subsidence in the vicinity of Taft and Dolores. Coral reefs, also, point to subsidence. Fig. 1 [fig. 5 of the present paper] is a profile of the ocean floor east of Taft and shows a gently shelving

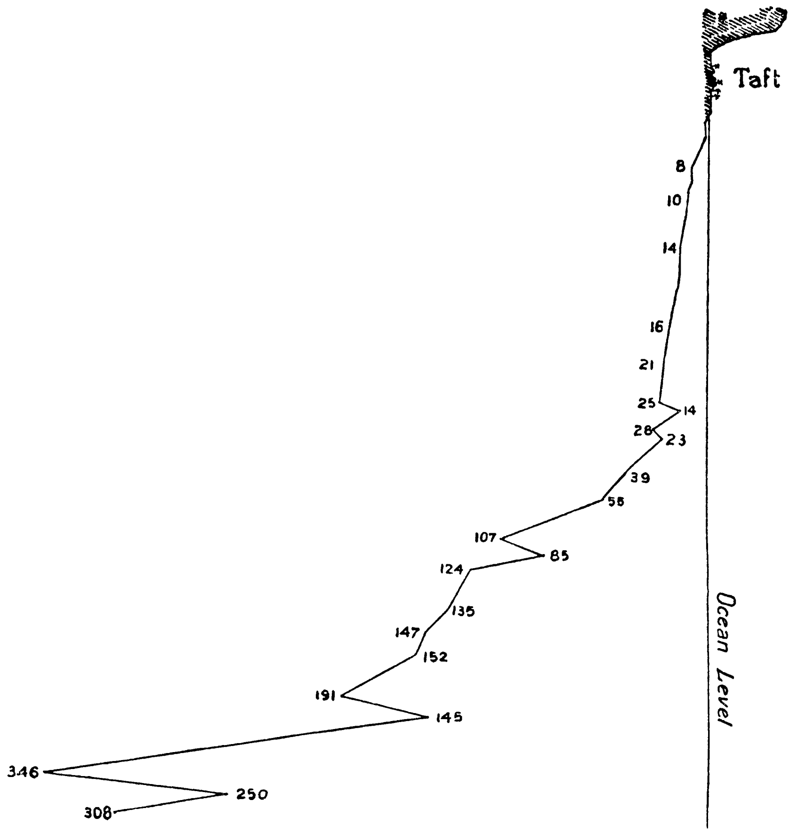


FIG. 5. Taft to the Pacific Ocean, Samar. Profile on an east and west line.

platform to the 25-fathom line, where there is an upbuilding, then the depths become greater, with fluctuations, out to the Pacific Deep. Fig. 2 [fig. 6 of this paper] is a similar profile from Dolores to Hilaban Island and likewise may indicate subsidence.

[2] Schenck, H. G., Physiography and geology of Samar, P. I., Philip. Journ. Sci. 20 (1922) 248–252.

The evidence seems to favor the theory expressed by Davis[3] that the existence of earlier formed reefs at lower levels, now drowned, is highly probable in many of the Philippine islands; for the absence of strong cliffs on headlands or back shores indicates the presence of protecting reefs while the coasts were suffering erosion before their recent subsidence.

Elsewhere Davis states:[4]

On the other hand, the northeastern coast of Samar, on the opposite side of the archipelago from Palawan, has a moderately sinuous shore line with delta flats that diminish the initial size of its bays, and fringing reefs that reach forward a mile or so from its points; here the latest submergence cannot be so recent as that of Palawan. But instead of being benched by a submerged platform, the sea bottom off shore from Samar sinks rapidly to a great depth.

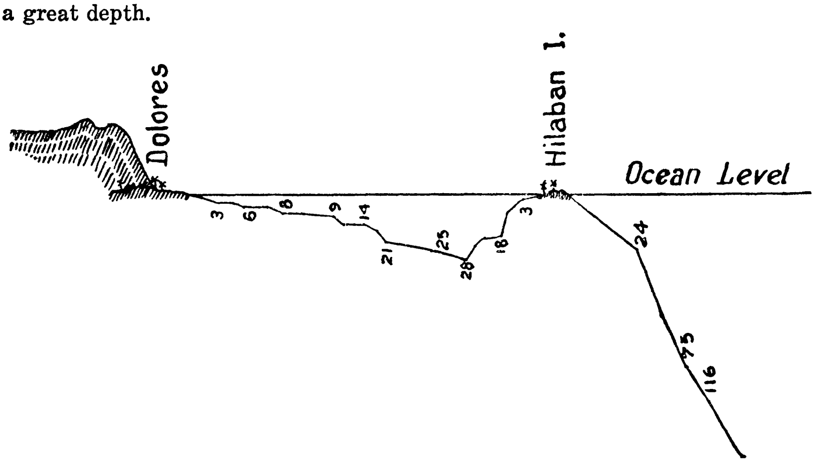


FIG. 6. Dolores to Hilaban, Samar. Profile on an east and west line.

Schenck's observations and Davis's interesting deductive studies which were based upon Coast and Geodetic Survey maps apparently indicate that the last movement on the eastern shore of Samar was one of depression (or rise of the sea according to Daly's Glacial Hypothesis). However, previous to this time evidences of the high terraces which are found to cross the middle portion of Samar are indicated by Schenck, as follows:[5]

At this point particular attention should be called to the long regular stretch of Dolores River from Hinolaso to Sumakay, to its long south-flowing

[3] Davis, W. M., Subsidence of reef-encircled islands, Bull. Geol. Soc. America 29 (1918) 517.

[4] Davis, W. M., Fringing reefs of the Philippine Islands, Proc. Nat. Acad. Sci. 4 (1918) 199.

[5] Op. cit. 251.

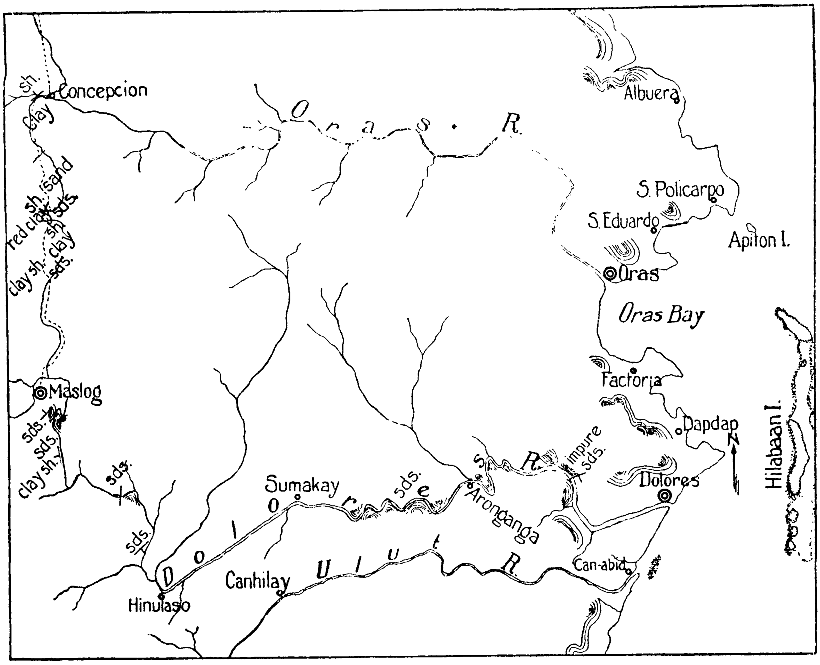


FIG. 7. The drainage on the east coast of Samar. These rivers are probably intrenched in an old marine Pleistocene plain.

tributary, and to a straight stretch of Ulot River corresponding to that of Dolores River. Farther east both rivers meander to a great extent. [See fig. 7.] Assuming the presence of an elevated marine terrace and further assuming that these rivers are antecedent streams, this phenomenon is readily explained, though a low anticlinal structure might be the controlling factor. It has been pointed out that evidences of uplift have been noted at several localities—and the island shown in Plate 1, fig. 1, furnishes marked indication of a terrace—on the west coast of the island, while definite evidence is not so marked on the Pacific side, although a recurring element in profile of certain portions of the east coast, for example at Palapag Mesa, may point to uplift. Terracing may have been general in extent. I am convinced that the section of Samar just described represents an old Pleistocene marine terrace; should this prove to be the case, Dickerson's idea of extensive terracing would certainly carry considerable weight.

Seemingly, the terracing on Samar, Leyte, and Bohol and the local depression described indicate that the combined mass was controlled by about the same set of forces during the Pleistocene. Leyte was during this time, in all probability, a series of small islands; most of Bohol was covered during early Pleistocene by the shallow water of a coralline sea (see Plate 1, fig. 2); and large portions of Samar were in all probability likewise covered.

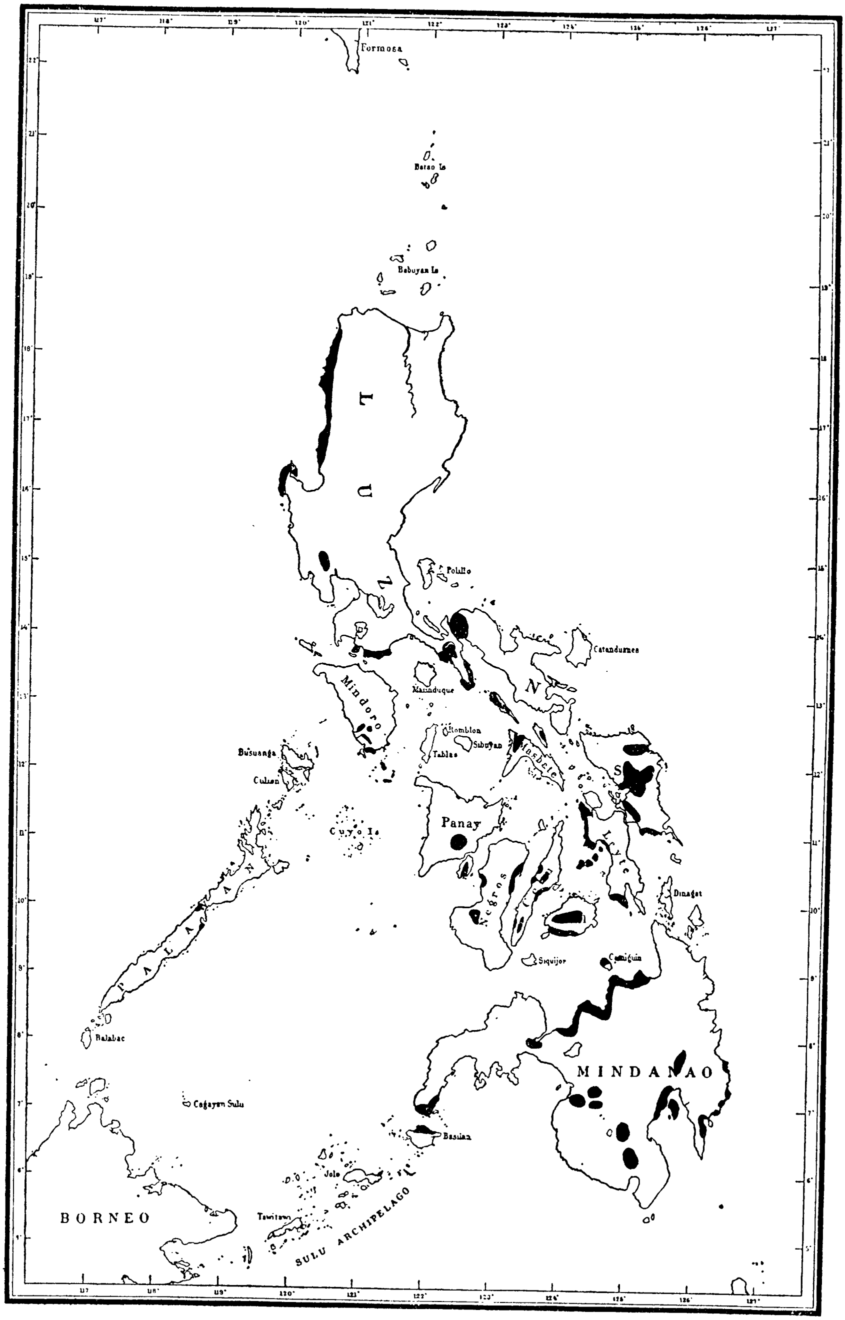


FIG. 8. The Philippine Islands, showing marine Pleistocene areas.

Since the succession of uplifts in middle or late Pleistocene time these three islands began to assume their present form and the Pleistocene Leyte archipelago supplied the late Pleistocene land masses with their present floras and faunas. (See fig. 8.)

In Cebu, 64 to 80 kilometers west of Leyte, there is a vastly different condition. The Pleistocene history of Cebu is highly complicated in detail and on this account only the broad outlines can be sketched. The city of Cebu is built upon two marine terraces, one about 3 meters above the present sea level and the other rising from about 9 to 18 meters. These two terraces stretch to the south and north of Cebu city on the east coast, giving a narrow but good means of travel along this coastal stretch. According to Smith, higher terraces, the uppermost of which is 300 meters high, are well developed in the hills near Cebu city. Similar terraces, resting unconformably on Malumbang limestone, were noticed on the west coast south of Barili at approximately the same elevations. A climb of 5 kilometers up the steep slopes from the village of Alegria on the west coast ends upon a plateau whose elevation is approximately 600 meters. My Filipino assistant, Mark Fuken, upon his own initiative, called attention to the remarkable evenness of this surface. This surface is cut across the truncate edges of the Malumbang sandstone, whose prevailing dip is 30°. Cebu is an upthrust block, Tañon Straits being the corresponding depression block, in a well-marked northeast-southwest fault system. Cebu in early Pleistocene time was a string of coralline-topped islets, which in later Pleistocene were united to form the Cebu of the present.

Recent explorations in Negros by Dr. W. D. Smith and Mr. Palmer Beckwith indicate an extensive terracing. A wide marine terrace occurs on the west side and narrowly skirts the east coast to the vicinity of San Carlos and beyond. According to Smith, this uplift is further indicated by incised meanders in the lower part of the volcanic plain which borders the marine plain.

Negros was intimately connected with Guimaras, Panay, Masbate, and Ticao during the Pleistocene. This fact is nicely brought out by tracing the 30-fathom line and the 100-fathom line on the Coast and Geodetic Survey chart No. 4718, of Panay, Negros, Cebu, and Masbate. Negros and Panay are closely connected to the northwest with Masbate by a sea which is everywhere less than 30 fathoms (180 feet) in depth. An

extensive series of marine terraces is reported by Abella, and later by Beckwith, in the vicinity immediately west of the town of Lucena, in central Panay. Five kilometers south of Ulian River, near Curoton, just north of Abangay River, marine gravel terraces of Pleistocene age rest unconformably upon a loose, fossiliferous sandstone of Malumbang age, about 40 kilometers north of the city of Iloilo in the central portion of Panay. Terraces are also reported farther to the north on the divide between Jalur and Panay Rivers. These marine terraces indicate that during one stage of the Pleistocene Panay was divided into at least two large islands. Some of these terraces reach an elevation of about 30 meters.

Guimaras is likewise terraced. Following the formation of terraces in Negros, Panay, Guimaras, and Masbate apparently the general region was uplifted without any marked faulting during the Pleistocene and a land mass of considerable extent in middle Pleistocene connected these large islands with Masbate to the northeast. Between the present sites of Panay and Negros to the south and Masbate to the northeast a broad low plain was developed. Ferguson first announced this interesting relationship in his paper upon the physiography of Masbate.[6] Further notes are given in a later paper upon the mineral resources of Aroroy district.[7] In the latter paper he states:

> Submergence again continued, giving the series of limestone terraces that form such a prominent feature of the topography between Point Colorada and Point Bugui. It is to be inferred from the courses of the present streams that the Aroroy district itself was at one time, at least in great part, covered by sediments. None of the principal streams shows adjustment to the present topography, and all may properly be classed as superimposed. After the period of sedimentation, the land surface was elevated to a point probably some sixty meters above its present level, and remained at this elevation long enough for a deep valley to be eroded out of the soft shales. Recent depression has converted this valley into the present Port Barrera. [See Plate 2, fig. 2.] Still more recent elevation, but only to the extent of some five or six meters, is shown in the raised coral reefs found on the northern shore of Point Colorada and on the coast east of Buyuan Bay. [See Plate 2.]

These higher terraces are beautifully shown in Plate 2, fig. 1, and are apparently at least 200 meters in elevation. These

[6] Ferguson, H. G., Physiography of the P. I., western Masbate, Philip. Journ. Sci. § A 4 (1909) 1–17.

[7] Ferguson, H. G., The geology and mineral resources of the Aroroy district, Masbate, Philip. Journ. Sci. § A 6 (1911) 413.

upper terraces are in all likelihood to be correlated with the same stages of terracing in Panay and Negros. Concerning the later stage Ferguson says in his paper upon the physiography of Masbate, page 12:

The submarine contours of Nin Bay suggest depression rather than elevation and this would be in accord with the topography of the coastal plain. An elevation of 35 meters would connect Masbate with Panay by a narrow ridge containing Jinototo and the two Zapatos Islands, which would stand out as peaks above the rest of the ridge. Mr. Worcester, reasoning from zoölogical evidence, suggested that Masbate, Panay, Guimaras, and Negros were formerly connected, and at least as far as concerns Masbate and Panay, the physiographic evidence confirms this. Dr. Becker, following this and from a study of the charts of these waters, suggests the separation of these islands by the submergence of a coastal peneplain.

On page 11, Ferguson offers interesting data substantiating the ideas of recent submergence in late Pleistocene time by giving details on the region around Nin Bay on the west side of Masbate. He gives further support to Becker's idea of peneplanation in his discussion of Malbug River.[8]

A peculiar feature of the topography of this part of the island [vicinity of Milagros southwest coast of larger arm of Masbate] is the course of the Malbug River, which rises near the northeastern coast and flows southeast parallel to the coast, until near Uson it makes a sharp turn at right angles to its former direction and flows southwest into the Gulf of Asid. The largest rivers of the island, the Asid and Malbug, drain into the shallow Gulf of Asid. The crests of the mountain ranges lie near the northern shore, there being a considerable stretch of plain and piedmont country on the southwestern side of the main prong of the island. Similarly, the greatest depths near the shore are to be found along the northern and northeastern coast, especially between Naro Bay and Point Bugui, where there is a depth of 911 meters at a point less than 3 kilometers north of Bagubau Point, while off the southern coast shoal water extends for a great distance. * * * The excellent harbors of Port Barrera (Aroroy), Port Palanog (Masbate), Naro Bay (Dimas-Alang), and Port Kataingan are situated on the northern and eastern coasts. On the west coast the only harbor is Port Mandaon. The Gulf of Asid, on the south coast, is so shallow that only small boats can call at Milagros.

Concerning the same matter, Becker[9] summarizes the conditions as follows:

If, for example, Negros, Guimaras, Panay, and Masbate were now to be depressed, even 100 feet or so, a very wide interval, 30 miles or more, would exist between Negros and Panay, while nearly as great a distance would

[8] Op. cit. 400.

[9] Becker, G. F., Report on the Geology of the P. I., U. S. Geological Survey, 21st Ann. Report Pt. III (1899–1900) 567.

intervene between Panay and Masbate. It is almost incredible that, in these quiet landlocked waters, connecting isthmian areas of such extent have been cut away by wave action and left no monadnocks to tell the tale. Inspection of the charts seems rather to indicate, in the shoal waters which separate this group of islands, a submerged coastal peneplain.

If a fluctuation such as is here suggested has occurred, it would have produced a nonconformity of erosion which would probably be traceable on minute study. It should certainly be sought when opportunity offers.

As Worcester and Bourns [10] point out, Negros, Panay, Guimaras, and Masbate are all of a zoölogical unit. McGregor (in litt.) notes that "the birds of Ticao show that this island belongs to the Masbate-Panay complex." A hydrographic map of this region has been drawn following the 30-fathom contour, 100-fathom contour, and the 200-fathom contour, to bring out the striking relationships described above (see fig. 9 and Plate 4). The cleverness of Becker's interpretation and the excellent support given to, and the strengthening of, his peneplain hypothesis by Ferguson, are excellent pieces of geological reasoning. However, there is no necessity in this case to postulate a broad, nearly uniform depression as the last event. A recent theory, which is particularly applicable to conditions such as are described above, in tropical regions, advances the explanation that the sea level rose at the close of the Pleistocene upon the restoration of waters previously withdrawn from circulation and tied up in glacial ice.

The first scientist to suggest a definite connection between the height of the sea level in the Tropics and the glaciation of the Pleistocene was A. Penck.[11] His statement is briefly set forth as follows:

The causes of the general rise of sea-level in the latest geological time might perhaps be connected with those climatic changes which the earth underwent in the Glacial period. If during that time, northern Europe, northern North America and the Antarctic regions were simultaneously glaciated, a considerable mass of water must have been removed from the ocean, and, if the thickness of the ice be assumed as 1,000 meters, the sea-level must have been 150 meters below its present position.

According to Daly,[12] the ice sheet at the 49th parallel of latitude, near the southern limit of the cap, was 6,000 feet

[10] Proc. U. S. Nat. Mus. **20** (1898) 549–625.

[11] Penck, A., Morphologie der Erdoberfläche **2** (1894) 660.

[12] Daly, R. A., Pleistocene glaciation and the coral reef problem, Am. Journ. Sci. IV **30** (1910) 299.

maximum, with an average thickness of 2,000 feet. Daly regards Penck's estimate as somewhat too high. He says:

The removal of enough water to form these great sheets of ice would tend to lower sea-level all around the globe by the amounts here approximately stated.

Estimated average thickness of ice in feet	3,000	3,600	4,000	5,000
Corresponding decrease of ocean's depth in feet	125	150	167	208

Woodward, Hergesell, and others have shown that a second cause for a negative movement of sea-level in the equatorial zone is to be found in the

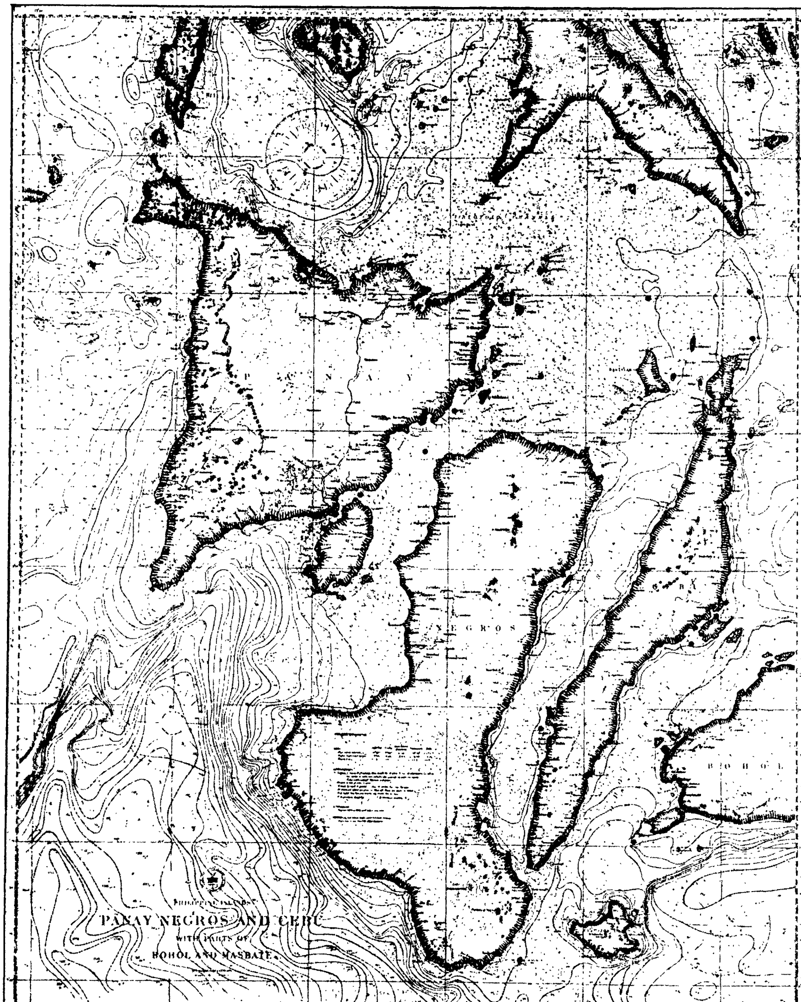


FIG. 9. Panay, Negros, and Cebu, and adjacent waters, showing isobaths.

gravitative power of ice. Using Woodward's formulas, it may be calculated that if the ice had an area of 6,000,000 square miles and an average thickness varying from 3,000 to 5,000 feet, the attraction of the ice would lower the level of the equatorial sea by amounts ranging from five to eight fathoms.

Taking the two effects together, the formation of the ice-sheets (which have since disappeared) would produce a negative movement of sea-level in low latitudes to an amount ranging between twenty to [and] forty-five fathoms. Assuming 3,000 feet as the average thickness of the ice, the shift of level in the equatorial sea would be about 30 fathoms.

As was indicated in previous discussion, without uplift this once broad, low-lying plain between Panay and Masbate has been partially covered by the waters restored from glacial ice at the close of the last phase of the Pleistocene, and the resultant drowned topography so beautifully exhibited in Masbate is now easily comprehensible. Upon the crest of the small elevations of late Pleistocene time coral polyps are now erecting their limestone platforms in the shallow area between Masbate and Negros (see Plate 4).

The startling conception of the Penck-Daly hypothesis surely aids greatly in interpreting this particular area. Apparently, this interpretation is further substantiated when the seaward extension of Cebu Island is studied.

Another interesting relationship exists between Ticao and Masbate. Ferguson calls attention to this in his papers referred to above. In his discussion of earthquakes [13] he states:

The Atlas de Filipinas divides the island between "rather frequent" and "rare" earthquake areas, the "rather frequent" zone lying, as would be expected, along the very deep Ticao strait between Masbate and Point Bugui. In a recent catalogue of destructive earthquakes, six earthquakes above VI of the Rossi-Forel scale are stated to have been felt in the years 1869, 1874, 1893, (two) 1897, 1900.

Recent work by Dr. A. N. Kryshtafovich upon Ticao indicates that Ferguson's ideas of faulting are quite correct. In addition, Kryshtafovich recognizes Ticao as a fault-block island with marked escarpment on the west and with gentle slopes toward the east. The mountain system of Ticao is apparently a very simple one, as a moderately elevated region with extreme altitudes of 322.5 to 348 meters with northwest-southeast trend, parallel to the southern branch of Masbate, runs close to its western shore in marked contrast to that of Masbate where the principal mountain range is situated closer to the eastern coast. The eastern shore of the island is low, abounding in deep bays

[13] Ferguson, H. J., Philip. Journ. Sci. § A **6** (1911) 401.

fringed with mangrove swamps in marked contrast with the steep and, in some places, even abrupt slopes on the west. This orographic condition is also reflected by the stream drainage, since all the important streams flow from the west to the eastern coast. Ticao is still connected at its southern extremity beneath the shallow waters of the sea with Masbate. Evidently the faulting which proved the separation of Ticao from Masbate is a comparatively late Pleistocene event, as coralline limestone of probable Pleistocene age has been given easterly inclination by the tipping of the block, since Ticao Strait is even now a decidedly seismic area. Movements along this fault line are probably continuing to-day, and the last movement recognized by Ferguson between low terraces in the vicinity of Point Colorada probably represents an exceedingly late Pleistocene or Recent uplift of the Masbate block.

But little is known concerning the Pleistocene of Palawan. A low, well-marked marine terrace occurs at Puerto Princesa according to photographs taken by Dr. Paul C. Freer, late director of the Bureau of Science (see Plate 1, fig. 3). The embayments, such as Malampaya Sound, indicate the drowned river valleys of a former cycle during which the island was at a much greater elevation than it is at present (see Plate 3, fig. 1). The marine terrace of Puerto Princesa on the east coast and Table Point terrace on the west probably indicate a still earlier cycle during which submergence was greater than that of the Recent. At present, the shore line indicates drowning of such an order that the rise of the sea in these tropical regions of 30 fathoms—the estimate of Daly—would be more than sufficient to flood the stream valleys of the second cycle. The 30-fathom curve of the Coast and Geodetic Survey illustrates this condition beautifully. The great limestone cliffs, 60 meters or more in height, which guard the entrance of Malampaya Sound and encircle several of the Calamianes, are notable features of western Palawan and the neighboring islands. The cliffs of St. Paul's Bay and the drowned mouth of its underground river, which launches can enter from the sea and navigate for about 6 kilometers, all testify to a great period of wave and stream erosion during which the great, wide, now submerged coastal plain was cut from the land in a period of higher-standing land than the present (see Plate 3, figs. 1, 2, and 3). Undoubtedly, more physiographic evidence will be found when this island shall have been studied in detail. During this high-

standing period Palawan was probably definitely and broadly connected to the south with Borneo and to the north less strongly with Mindoro by a chain through the Calamianes as shown by the distribution of fresh-water fishes (see fig. 10). There are several suggestive coastal characters, such as the probable north-south Princesa fault which probably indicates a definite movement of the south half of Palawan upward with the north half correspondingly depressed, which complicate the picture and prevent us from drawing any but broad sketch lines of the history of this interesting elongate island (see fig. 11). The last event, at any rate in the northern half of the island, has been drowning, which as far as we can see may be explained by a down-movement along the Princesa fault or by the flooding of the restored glacial waters, or both, at the close of the Pleistocene.

Zoölogically and botanically the Calamianes and Palawan are in broad terms a unit with a dominantly Bornean flora and fauna. Mindoro is less strictly Bornean with more endemic species, both plant and animal, than Palawan. Such forms as the unique timarau (*Bubalus mindorensis*), a dwarf water buffalo, a distinct Asian form, is, judging by its resemblance to the common water buffalo, a species which developed in the late Pleistocene from an ancestral early Pleistocene or Pliocene type. Such endemism, which is probably the result of isolation, indicates that Mindoro was separated from Palawan previous to Palawan's separation from Borneo. The present known fragmentary story of Pleistocene geology of Mindoro leads to the same conclusion.

Mr. Graham B. Moody reports coralline limestone from Mindoro from Hospital Hill, which is about 300 meters in elevation, on the side of Lumintao River about 2.5 kilometers from this stream (121° 6′ east longitude, 12° 35′ north latitude). He says:

> Coralline limestone containing large coral heads is found in a low hill on Amauking River about 1.5 kilometers northeast of the barrio of Calintaan (120° 56′ east longitude, 12° 35′ north latitude); in a low hill on the trail between Calintaan and Lumintao River in Caguray River about 0.5 kilometer due south of Doctor Daywalt's house and the terraced 117.5-meter Santa Teresa Hill (12° 16′ north latitude, 121° 8′ east longitude). The distribution of this coralline limestone indicates an emergence of at least 300 meters since Pleistocene time. Practically all of this limestone has been eroded away

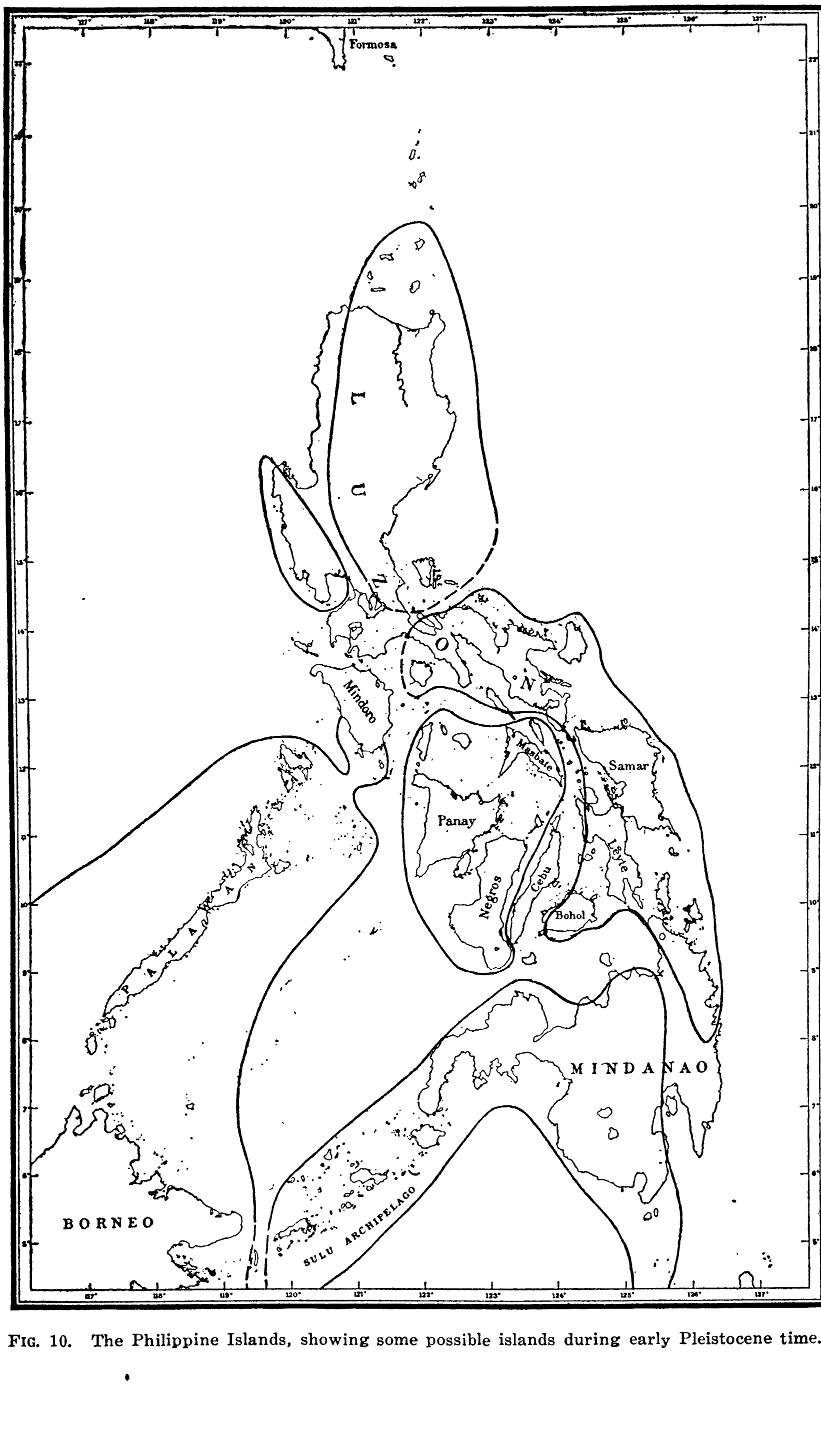


FIG. 10. The Philippine Islands, showing some possible islands during early Pleistocene time.

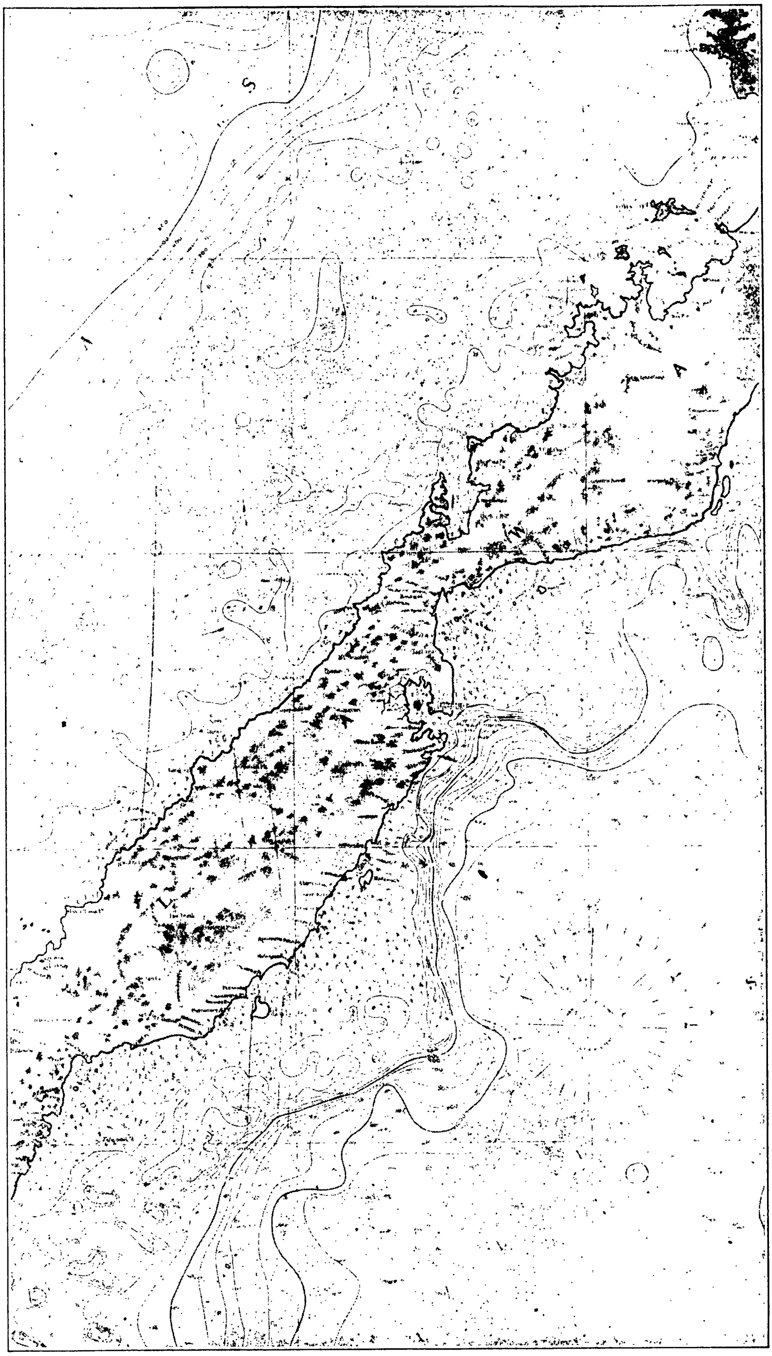


FIG. 11. Central Palawan and adjacent waters, showing isobaths.

and but small residuals remain to evidence the presence of a Pleistocene sea. Bugsanga and Lumintao Rivers, which are large streams on the southwest coast of Mindoro, have nearly a parallel course for 32 kilometers upstream from their mouths. Now these streams in a place 24 kilometers upstream are separated by but 5 kilometers, a very remarkable fact when one remembers that they are master streams. The probable interpretation of this drainage is that these rivers started as streams on a low coastal plain which was so slowly uplifted that both streams maintained their courses by downward erosion against uplift. This once low coastal plain may correspond to the 300-meter terrace of Hospital Hill, and the later slow uplift stages may be recorded by the terraces of Santa Teresa Hill. Previous to the cutting of the 300-meter terrace Mindoro was, in all probability, more emergent than at present and was at that time connected to the south with Palawan.

Tablas Island probably emerged during late Pleistocene as an upthrust block between two well-marked faults. It is so recent geologically that its biological story is in all probability a short one. However, a biological study of such an island would give much interesting information which would contrast strongly with that of its richer neighbors.

The large island Luzon has had an exceedingly complicated Pleistocene history and, since but little attention has been paid to the study of marine terraces, there are great gaps in our knowledge of this interesting, irregularly formed island. In its western portion considerable study has been made of Bondoc Peninsula which lies within the longer and more irregular Camarines Peninsula. On the west side of Bondoc Peninsula, about 1.5 kilometers east of Pinamuntangan Point, at an elevation of 82.5 to 90 meters, a very excellently preserved Pleistocene fauna, containing gastropods and pelecypods in addition to the reef corals, establishes a definite Pleistocene horizon at this place. As Mr. Moody found in Mindoro, this occurrence is a mere residual, as the soft underlying shales and sandstone of the Vigo group have been easily eroded by the torrential rains of this region. A still higher terrace, about 150 meters in elevation, occurs in the region east of Mulanay poblacion, the principal town in the southern part on the west coast of this peninsula. In this vicinity there are several excellent residuals which evidence this now much-eroded marine terrace.

On both the west and the east sides of this peninsula one of the notable physiographic features is the peculiar habit of several of the master streams of breaking through a solid wall of compact coralline limestone of Malumbang age. The Catanauan, the Ajus, the Mulanay, the Matataha, the Ayni, and possibly the Silongin (Canguinsa) exhibit this habit on the west coast, while the Guinhalinan, the Vigo, and the Bahay on the east exhibit the same phenomenon of breaking through a limestone wall with a wide shallow valley above. The history of this peninsula is similar to that of the streams in the northwest part of Leyte as described above. In Bondoc Peninsula the master streams were practically all initiated upon a low coastal plain that spread entirely across this peninsula. This low coastal plain was for the most part covered by the sediments and coralline limestones of the early or middle Pleistocene age, and a few monadnocks of a former cycle rose above this even surface. As progressive uplift occurred these streams began to incise this plain and exhumed the Vigo and Malumbang strata. The Vigo, being on the whole largely composed of shales in this peninsula, was far more easily eroded than the compact limestone of the Malumbang and, back of the westerly or easterly dipping Malumbang limestone, according to their respective coasts upon which these streams occurred, wide valleys developed in the soft Vigo shales and sandstones. At a later stage some drowning of these streams may have occurred; but in practically all cases the resulting bays have been filled by alluvium from the surrounding hills. Pagsangahan River in the south end of the peninsula passes through a valley whose feature is difficult to explain upon any other hypothesis. Most of the streams are tidal for the lower 2 or 3 kilometers of their courses. The same condition probably prevailed through the northern half of this peninsula as well. In the low divide between Calauag Bay and Ragay Gulf, an excellent 9-meter terrace marked by coralline limestone, which is found resting unconformably upon the truncate edges of Vigo shales, clearly evidences a stage during which a Pleistocene Camarines island existed. Based upon the study of the terrace on the south end of Bondoc Peninsula, it is probable that a wide channel existed at a still earlier stage of the Pleistocene connecting the greater Limon Bay with the southern Sibuyan Sea to the south. W. D. Smith reports the Paracale

district, Camarines, as being drowned. The general broken character of this region is in accord with his specially studied case, and here again drowning is probably the episode which closed the Pleistocene.

One of the most striking bits of coastal scenery occurs on the south coast of Batangas at Malbrigo Point. Fairly broad-stepped terraces, in beautiful succession, rise gradually to an uppermost tread of 180 meters. Well-marked evidence of a marine Pleistocene terrace is reported by Smith from the vicinity of Bamban, Tarlac Province, in the great valley of Luzon. So recent is the conquest of this great valley by the land from the sea that, within historic times, canoes have been enabled to pass during flood seasons from Manila Bay to Lingayen Gulf, and only within recent or late Pleistocene times, through a double process of uplift and filling, has the Pleistocene Zambales island been stoutly tied to its master, Luzon. Further evidence for this is found in the peninsula which forms the western side of Lingayen Gulf. On the westward or seaward side there exists a well-developed system of marine terraces upon which Mr. P. R. Fanning reports numerous residuals of coralline limestone. The low Cabarruyan Island in Lingayen Gulf also evidences uplift. This island has been rather recently disconnected from the mainland. From this island, near the town of Anda, a small tooth of a young individual of *Elephas* species is reported to have been collected.

Along the western coast of Ilocos Sur, Ilocos Norte, the Mountain Province, and a portion of La Union Province, well-marked marine terraces of two or three different stages are clearly seen. These terraces extend to an elevation of 75 to 90 meters in the coastal region south of Vigan. In the vicinity of the last-mentioned town, Abra River breaks through a 600-meter range of diorite but 3.2 kilometers from its mouth in the China Sea. The abrupt western face of this diorite range extends northeastward for many kilometers, and it is sharply set off from the marine terraces whose elevation approximates 30 to 45 meters. Evidently, this range has been rather recently thrust up along a well-marked rift whose general trend is north 15° east. This region of faulting is in all probability not wholly simple but consists of several parallel, or approximately parallel, faults, as that marked feature of recent rifting known as kernbuts occurs between these parallel faults. These kernbuts in the valley of Kern River, California, which are typically de-

scribed by Lawson,[14] are due to differential displacements between parallel faults. In addition to this well-marked feature, the water gap of the Abra near Vigan is inexplicable on any other basis than that of antecedency, as there is a far easier course across the softer Tertiary rocks a short distance south of Sulvec Point. By movement along the Abra Fault in late Pleistocene time this range of diorite was upthrust against the down-cutting Abra (see fig. 12). In this particular region faulting undoubtedly has complicated the Pleistocene problem greatly and in even late Pleistocene time great movements have occurred along many of these fault lines. This is quite evident when the region around Baguio and Trinidad in Benguet Subprovince, Mountain Province, is studied. Baguio City and Trinidad Valley are located on a high upland plateau, whose elevation is from 1,200 to 1,500 meters. The Tertiary history of this plateau has been worked out in some detail by Dickerson,[15] whose conclusions are that this plateau is a peneplain developed near sea level during early or middle Pleistocene time, hoisted by faulting on a great scale during the late Pleistocene and that, owing to the torrential tropical rains, much of its area has, even during late geologic and Recent times, been removed entirely from large areas. Only such residuals as the Baguio Plateau, Haight's Plateau, and Mount Data Plateau remain to evidence this once extensive upland. Farther to the east and north of this plateau higher mountains, attaining elevations of 1,200 to 1,500 meters, probably existed during the Pleistocene, and upon these higher and colder peaks the representatives of the early Formosan-Himalayan flora were preserved.

Cagayan River, in Cagayan Valley, northern Luzon, passes through low hills even a few kilometers south from Aparri, the port at its mouth; and, according to certain contour maps, this stream is intrenched in a series of low hills from which it has cut narrow shallow valleys. No definite information is available, but it seems entirely probable that Cagayan Valley was occupied by the sea during late Pleistocene time.

The Babuyan Islands, immediately to the north of Luzon, are in part limestone, in part volcanics. Fuga and Calayan Islands are, according to Mr. McGregor, ornithologist of the

[14] Lawson, A. C., The geomorphogeny of the Upper Kern Basin, Univ. Calif. Publ. Dept. Geol. No. 15 **3** (1902–1904) 291–376.

[15] Dickerson, R. E., The development of Baguio Plateau, Philip. Journ. Sci. **23** (1923) 413–453.

FIG. 12. Part of northern Luzon, showing Abra Water Gap.

Bureau of Science, composed of limestones; and these limestones, in turn, are cut by a series of terraces. Fuga is entirely composed of limestone, whereas Calayan exposes columnar lava also. The channel separating Fuga from the mainland is shallow. According to Ferguson, who visited Camiguin, this island is built up of various lava flows interbedded with volcanic agglomerate and is apparently a quite recent product of volcanism. Babuyan Claro, the island north of Camiguin, is volcanic, according to Ferguson. The Babuyan Islands are separated from the Batanes by Balintang Channel which has considerable depth. Of these islands, Ferguson reports a marine terrace at 270 meters on Batan Island and one at 210 meters on Sabtan Island. According to him: [16]

> The island of Ibujos consists entirely of coral limestone rising in steep cliffs to a height of over 60 meters. These surround the island, except on the eastern side where the land rises gently from the fringe of sand dunes and small ponds around the shore, in contrast to the 300-meter agglomerate cliffs of the island of Sabtan less than 2 kilometers distant. The surface of Ibujos is gently rolling, but without any streams or definite stream valleys. This condition is partly due to the solubility of the rock which allows water to run off in underground channels, but it is also in large part an effect of the recent date of the uplift, which has not allowed sufficient time for the streams to form valleys. * * *
>
> Isbayat, the largest island of the group is likewise entirely surrounded by cliffs, the only landings being steps cut in the rock in one place, and a series of ladders in the other. From the deck of the steamer the cliffs seemed to be similar to the limestone cliff of Diojo Point on the north of Batan Island, and I am told by people who have visited the island that the land slopes downward from the top of the cliffs toward the villages which are situated in small "sinks." This fact inclines me to believe that Isbayat is formed of limestone, rather than that it is of volcanic origin.

According to a letter written by an American school teacher, who for some time lived in Isbayat, the island contains notable caves in limestone. Y'Ami, the northernmost island of this group, is according to Ferguson volcanic except for a fringe of coral near the shore. The limestone reported upon these islands is probably of varying ages from Vigo-Miocene to Pleistocene, as one sample of *Lepidocyclina* limestone is in the collection of the Bureau of Science from Batan Island. The connection of the Batanes with the Babuyanes and, in turn, Luzon during the Pleistocene seems rather unlikely. The Babuyan Islands, on the other hand, may have been directly connected with Luzon during a high-standing period of this land mass during early Pleistocene.

[16] Ferguson, H. G., Philip. Journ. Sci. § A 3 (1908) 12.

SUMMARY

Such then are mere sketch lines of the intricate Pleistocene design but, although the gaps in the information are very great, certain of the larger features of the Pleistocene Philippine archipelago are clear in broad outline.

One of the most interesting results of this study of paleogeography of the Philippines is the conclusion that northern Luzon has during Vigo-Miocene, Malumbang-Pliocene, and Pleistocene times contained within its mass somewhere high-standing land with elevations of from 1,200 to 1,500 meters. The evidence for this conclusion is based upon the paleobotanical and botanical work of Elmer D. Merrill, former director of the Philippine Bureau of Science. On this continuously present Tertiary island of Luzon the remnants of a Himalayan-Formosan flora have been preserved. From the south during Vigo-Miocene time and, possibly, during the interval between the Vigo-Miocene and Malumbang-Pliocene times, the plants and animals of Malaysia spread northward upon the elongate Palawan-like island which probably existed on the eastern side of this archipelago. Not only did this land mass offer passage for the Celebesian forms of plant and animal life, but it seems highly probable that at this stage slight connections by way of a Talaur isthmus or island row were had with the Moluccas and, in turn, with New Guinea. The repeated appearance of this elongate island or row of islands during Malumbang time again offered a probable migration route for life forms. From this same Pliocene island or long island chain, Pliocene Leyte may have derived its fauna and flora and, in turn, a certain number of species may have spread to Negros and other island masses occupying, in part, the present sites of Negros and Panay.

The kaleidoscopic changes of the Pleistocene with its alternating cold and warm periods has left a peculiarly perplexing Philippine record, which can only be read by a study of the physiography of these islands. The great movements along dominant faults during the late Pleistocene and Recent times are absolutely astounding and the great acceleration of the processes of erosion due to the torrential character of the tropical rainfall startle the student of physiography whose training was obtained in more temperate climes.

The direct effects of glacial chill were, in all probability, damped in the Philippines, as the persistence of reef corals at

various Pleistocene horizons indicates warm marine waters throughout this period in this region. All the molluscan species thus far collected from Pleistocene beds are clearly referable to living forms. This indicates that no marked change in temperature of the Philippine sea water took place during the Pleistocene, since one of the most effective agents in producing specific change in marine littoral forms is temperature. However, the probable withdrawals of sea waters during the cold phases of the Pleistocene and their later restoration during the warm phases doubtless opened and shut many "portals" and these powerful indirect effects are reflected in the migrations of plants and animals and their very high specific endemism.

During the early Pleistocene a high-standing stage is recognized in northern Luzon during which a large portion of this region was reduced by subaërial erosion to a low-lying plain with mountains to the north and east of the present site of Baguio, Benguet, which attained a height of 1,200 to 1,500 meters. After this plain was developed the whole region was elevated in middle or late Pleistocene time, faulted, and during the late Pleistocene and Recent eroded so thoroughly that but relatively small remnants now record this Pleistocene history. The marine terraces along the western coast from Lingayen Gulf to Vigan and possibly farther north may represent the seaward edge of Baguio Plateau broken off by faulting from the rest of this notable feature.

The terraces of the Pleistocene Zambales island record a depression of at least 100 meters greater than the present during which this island was distinctly separated from the main mass of Luzon by a strait. Later through uplift and filling, this strait has been closed, thus tying this island to its present master, Luzon. During late Pleistocene time the waters of the Pacific Ocean had a free passage across the northern end of Bondoc Peninsula, and the Camarines island with its smoking sulphurous volcanoes of Mayon, Isarog, and Bulusan, dominated the central Philippine archipelago. Just what relation this Camarines island bore to the large land mass to the southwest is not clear. It is possible that a land connection existed in this direction. Panay, Masbate, Negros, and Ticao during early Pleistocene formed a compact mass upon which an extensive low-lying plain was developed during a high-standing stage of the land. During late Pleistocene, or even at the close of the

Pleistocene, this plain was covered by the waters restored by the melting of the glacial ice in high latitudes. Faulting was active along the northeastern portion of this land mass and Ticao was broken off and tilted and the intervening block sank beneath the sea.

During middle Pleistocene Samar, Leyte, and Bohol were largely submerged. Later they were uplifted and possibly for a short period united only to be separated again by the last flooding which merged into Recent time.

Mindanao had largely a separate history consisting of first, an elevated stage; second, erosion; third, a flooding with an archipelagic condition; fourth, union through uplift resulting in the second largest Philippine island of to-day.

Palawan was in early or middle Pleistocene broadly connected to the south with Borneo; then, possibly, great movements along the southern extension of Taal fault dropped in an extensive block on its western side, further elevating and outlining of Palawan took place, many rivers eroded such valleys as the one now occupied by Malampaya Sound and, finally, in latest Pleistocene time, this vassal of Borneo was freed from its dependent state and given an independent existence of its own.

ILLUSTRATIONS

FIG. 7. Map showing the drainage on the east coast of Samar. These rivers are probably intrenched in an old marine Pleistocene plain. (After Schenck.)

8. Map showing marine Pleistocene areas in the Philippines.

9. Isobathic map of Panay, Negros, and Cebu. Prepared by Mr. John Bach, under the direction of Capt. E. H. Pagenhart, director, Bureau of Coast and Geodetic Survey.

10. Map showing some possible Philippine islands during early Pleistocene time.

11. Isobathic map of central Palawan.

12. Contour map of a part of northern Luzon showing Abra Water Gap.

Fig. 1. Banisilan, Mindanao, looking west across the oldest river bench.

Fig. 2. Marine terrace in central Bohol.

Fig. 3. Puerto Princesa, Palawan.

PLATE 1.

Oversized Foldout

Fig. 1. Malampaya Sound, Palawan.

Fig. 2. St. Paul's River, Palawan. Entrance to cave.

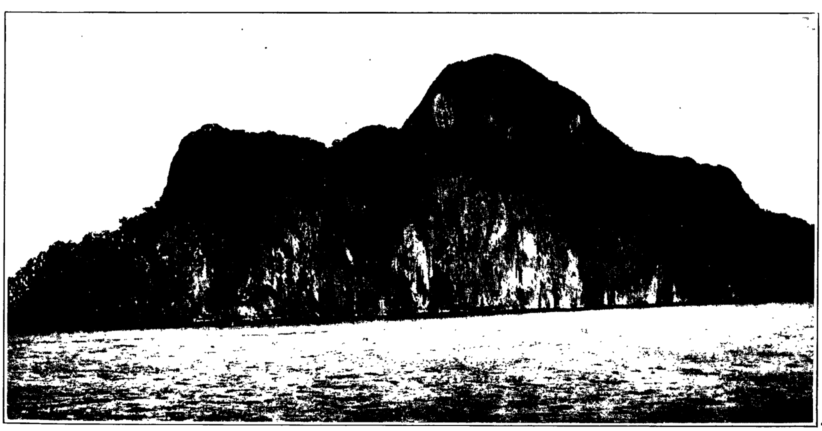


Fig. 3. Headlands of St. Paul's Bay, Palawan.

PLATE 3.

PLATE 4. THE PHILIPPINE ISLANDS, SHOWING THE TOPOGRAPHY AND THE HYDROGRAPHY.

ABSORPTION OF CULTURE SOLUTIONS BY COCO-PALM ROOTS [1]

By R. B. ESPINO and JOSE B. JULIANO
Of the College of Agriculture, Los Baños

SIX TEXT FIGURES

INTRODUCTION

The present study deals with the rate of absorption of complete nutrient solutions by the roots of the coco palm (*Cocos nucifera* Linnæus). The results of this study may be of value to indicate the amount of water that the plant requires. It may also suggest something with regard to its fertilizer requirements.

Copeland,(2) working with the San Ramon type of coco palm, performed a similar study under the environmental conditions in San Ramon, Zamboanga, Mindanao. He found that the rate of absorption of solution of potassium nitrate varied with the different concentrations tested. Complete nutrient solutions have never been tried with the coco palm. Other plants, such as wheat,(9) buckwheat,(7, 8) and rice,(4) when grown in some complete and balanced culture solutions showed normal growth—much better than that obtained from similar plants when grown in single-salt solutions. Osterhout(6) found that single-salt solutions are far more toxic to plants than solutions containing two or more salts. For this reason it was deemed advisable to amplify the studies made by Copeland and to try complete nutrient solutions. The Laguna variety of coco palm, grown at the College of Agriculture, Los Baños, Luzon, was employed in the present study, which lasted from September, 1921, to December, 1922, inclusive.

EXPERIMENTS AND RESULTS

CULTURE SOLUTIONS EMPLOYED

Eight different sets of molecular salt proportions, as shown in Table 1, were used for this type. They all had the same

[1] Thesis presented for graduation from the College of Agriculture; Experiment Station contribution, No. 233.

total concentration of 0.0245 gram-molecule of the salts per liter. These will be known as the 3-salt type.

Twelve culture solutions, as given in Table 2, were tested for this type, and each of them had a total concentration of 0.0384 gram-molecule of all salts per liter. These will be designated as the 4-salt type.

In the later part of this study only two culture solutions of the 3-salt type and three of the 4-salt type most readily absorbed were further tested. Four concentrations, 0.0192, 0.0384, 0.0768, and 0.1152 gram-molecule of all the salts per liter, were employed in the case of the 4-salt type except that culture solution B_4 had 0.0960 gram-molecule because precipitates were formed in concentrations higher than this one. The cultures of the 3-salt type were 0.01225, 0.0245, 0.0490, and 0.0980 gram-molecule (of all the salts employed) per liter.

PREPARATION OF THE SINGLE-SALT STOCK AND CULTURE SOLUTIONS

The single-salt stock solutions were prepared separately in half-molar concentration by using distilled water and "Baker's analyzed" monopotassium phosphate (KH_2PO_4), calcium nitrate [$Ca(NO_3)_2$], magnesium sulphate ($MgSO_4$), and ammonium sulphate [$(NH_4)_2SO_4$].

TABLE 1.—*Proportion of the single-salt solutions in each culture solution.*[a]

[Total concentration, 0.0245 gram-molecule of all salts taken together per liter.]

Culture solution.	Gram-molecule of each salt in culture solutions.		
	Monopotassium phosphate, KH_2PO_4.	Calcium nitrate, $Ca(NO_3)_2$.	Magnesium sulphate, $MgSO_4$.
A_3	0.0035	0.0035	0.0175
B_3	0.0035	0.0105	0.0105
C_3	0.0035	0.0175	0.0035
D_3	0.0070	0.0070	0.0105
E_3	0.0070	0.0105	0.0070
F_3	0.0105	0.0035	0.0105
G_3	0.0105	0.0105	0.0035
H_3	0.0175	0.0035	0.0035

[a] Some of the solutions employed by Espino.

TABLE 2.—*Proportion of the single-salt solutions in each culture solution.* [a]

[Total concentration, 0.0384 gram-molecule of all salts taken together per liter.]

Culture solution.	Gram-molecule of each salt in culture solutions.			
	Ammonium sulphate, $(NH_4)_2 SO_4$.	Monopotassium phosphate, $KH_2 PO_4$.	Calcium nitrate, $Ca (NO_3)_2$.	Magnesium sulphate, $MgSO_4$.
A_4	0.0048	0.0048	0.0048	0.0240
B_4	0.0048	0.0048	0.0144	0.0144
C_4	0.0048	0.0048	0.0240	0.0048
D_4	0.0048	0.0096	0.0096	0.0144
E_4	0.0048	0.0096	0.0144	0.0096
F_4	0.0048	0.0144	0.0048	0.0144
G_4	0.0048	0.0144	0.0144	0.0048
H_4	0.0048	0.0240	0.0048	0.0048
I_4	0.0144	0.0048	0.0048	0.0144
J_4	0.0144	0.0048	0.0144	0.0048
K_4	0.0144	0.0144	0.0048	0.0048
L_4	0.0240	0.0048	0.0048	0.0048

[a] Some of the solutions employed by Espino.

In the proportions indicated in Tables 1 and 2 each solution was prepared by mixing the required amount of salts in a flask about two-thirds full of distilled water. One by one the salt solutions were poured into the flask. In order to avoid the formation of precipitates the contents of the flask were shaken while each salt solution was being added. A few drops of ferric chloride solution were added to each mixture, and water was further added up to the mark on the neck of the flask. The culture solution was then ready for use.

Sixty cubic centimeters of each culture solution were poured into a 100-cubic-centimeter bottle. Into this mixture a root of a coco palm was inserted to a length of about 5 centimeters. A paraffined cork stopper of suitable size and cotton fiber plugged the mouth of the bottle. This was done in order to avoid the loss of water from the mixture through evaporation. During the early part of the study each culture solution was renewed every three days; but later, when the study was mainly on the concentrations of the culture solutions, the interval was reduced to two days. Still later the renewal was made daily.

OTHER PREPARATIONS

The roots were dug out of the ground. Care was taken not to bruise or injure them. Then they were washed with water and the portion of each root not needed in the experiment was again buried in the ground. These roots were placed separately in bottles of water for several hours. Thence, they were transferred into the culture solutions contained in bottles, each of which was laid in one-half of a split bamboo joint; the other half was then placed over it. This step was taken to insure cleanliness and darkness for the root. A shelter of suitable size was built around the stem of each tree about 1.5 meters from the ground. This shelter kept the rain and sun heat from interfering with the experiments.

At the time of changing the solution the bamboo joint was opened. The bottle was carefully removed and the amount of the solution absorbed was determined by weighing. Care was always exercised to effect the change of a culture solution within one minute.

FURTHER PLAN OF EXPERIMENTS AND RESULTS

Some roots from one coco palm about five years of age were employed as the living indicators of this study. Eight roots from the tree were supplied with the eight culture solutions of the 3-salt type. Each culture solution was tried on every root, but on different days, and had a concentration of 0.0245 gram-molecule of all salts taken together per liter. The results of the experiments are summarized in Tables 3 and 4.

Each of the twelve culture solutions of the 4-salt type was served to every one of the twelve roots of the same tree. Only one concentration (0.0384 gram-molecule per liter of all the salts together) of the culture solutions was here employed. The summary of the results obtained is given in Tables 5 and 6.

The two culture solutions E_3 and G_3 from the 3-salt type most readily absorbed were further tested in four different concentrations. These were 0.01125, 0.0245, 0.0490, and 0.0980 gram-molecule of all the salts together per liter. Culture E_3 in the four molecular concentrations was supplied alternately or in cycle to four roots from one tree. In a similar manner culture G_3 was supplied to another set of four roots, but from another tree.

TABLE 3.—*Average daily absorption records exceeding 1 gram; compiled from the data on hand.*

[All readings in grams.]

Culture solution.	Root 1.	Root 2.	Root 3.	Root 4.	Root 5.	Root 6.	Root 7.	Root 8.	Root 9.	Roots which absorbed the solution rapidly.
A_3						1.215				1
B_3			1.208							1
C_3										0
D_3										0
E_3							1.115	1.260		2
F_3			1.026		1.089					2
G_3	1.014	1.273		1.056			1.077			4
H_3		1.001	1.036							2

TABLE 4.—*Records of average daily absorption. Two culture solutions most readily absorbed by each root were selected from data on hand.*

[All readings in grams.]

Culture solution.	Root 1.	Root 2.	Root 3.	Root 4.	Root 5.	Root 6.	Root 7.	Root 8.	Average.	Roots with readings of each solution.
A_3					0.934		1.215		0.818	2
B_3				1.208		0.899			0.805	2
C_2			0.972						0.735	1
D_3									0.608	0
E_3	0.872	0.977					1.115	1.260	0.866	4
F_3					1.089				0.817	1
G_3	1.014	1.273		1.056				1.077	0.825	4
H_3			1.001	1.036					0.808	2

TABLE 5.—*Records of average daily absorption, exceeding 1 gram; compiled from data on hand.*

[All readings in grams.]

Culture solution.	Root 1.	Root 2.	Root 3.	Root 4.	Root 5.	Root 6.	Root 7.	Root 8.	Root 9.	Root 10.	Root 11.	Root 12.	Roots which absorbed the solution rapidly.
A_4		1.595	1.763		1.312						1.467	1.205	5
B_4		1.429	1.670									1.500	3
C_4													0
D_4													0
E_4		1.401	1.051	1.011		1.334	2.149						5
F_4			1.252				1.631						2
G_4							1.103		1.354	1.373			3
H_4									1.125				1
I_4							1.188			1.117	1.064		3
J_4							1.477						1
K_4												1.115	1
L_4	1.325			1.134									2

TABLE 6.—*Records of average daily absorption. Three cul ture solutions most readily absorbed by each root were selected from data on hand.*

[All readings in grams.]

Culture solution.	Root 1.	Root 2.	Root 3.	Root 4.	Root 5.	Root 6.	Root 7.	Root 8.	Root 9.	Root 10.	Root 11.	Root 12.	Average.	Roots with readings of each solution.
A_4	0.937	1.595	1.763	0.846	1.312			0.903			1.467	1.205	1.029	8
B_4		1.429	1.670	0.978	0.799	0.904		0.735	0.717			1.500	0.911	8
C_4									0.763			0.854	0.618	2
D_4						0.932							0.588	1
E_4	0.755	1.401	1.051	1.011		1.334	2.149	0.570					0.879	7
F_4	0.772		1.252	0.899			1.631						0.675	4
G_4						0.955			1.354	1.173			0.677	3
H_4									1.125	0.817			0.582	2
I_4	0.505				0.800		1.188			1.117	1.064		0.679	5
J_4							1.477			0.818	0.852		0.616	3
K_4											0.981	1.115	0.522	2
L_4		1.325			1.134			0.955					0.710	3

This procedure was also followed in connection with cultures A_4, B_4, and E_4, in four different concentrations supplied to a set of four roots from a tree. Four roots from each of five coco palms were here used as living indicators. With this arrangement the data in Table 7 are not always comparable with one another. Only the data in each column are comparable with one another, while the numerical data in the horizontal lines should not be compared with one another because they represent average daily absorption of roots of four different trees. The data for the 4-salt and those for the 3-salt culture solutions shown in Table 7 were compiled from the mass of data on hand.

TABLE 7.—*Average daily absorption*[a] *of each culture solution of different concentrations by the different roots.*

Concentration of culture solution. Gram-molecule of all salts per liter.	Culture solutions.				
	A_4	B_4[b]	E_4	E_3	G_3
	g.	*g.*	*g.*	*g.*	*g.*
0.0192	0.4288	0.2198	0.2471	----------	--------
0.0384	0.4369	0.3045	0.3301	----------	--------
0.0768	0.5167	0.3114	0.3904	----------	--------
0.1152	0.5566	0.3566	0.4728	----------	--------
0.01225	----------	----------	----------	0.2871	0.3340
0.02450	----------	----------	----------	0.2943	0.3374
0.04900	----------	----------	----------	0.3101	0.3939
0.09800	----------	----------	----------	0.2730	0.3196

[a] Numerical data in each column are comparable with one another; those in the horizontal lines, not.

[b] Concentration was 0.0960 gram-molecule of all the salts taken together per liter. Precipitates formed when concentrations were greater than this one.

As shown in preceding tables the culture solution most readily absorbed from the 3-salt type was E_3, and the one from the 4-salt type was A_4. These two cultures were compared under the same concentration, 0.098 gram-molecule (of all the salts taken together) per liter. Two roots from the same tree were here employed, and readings on absorption were taken once a day. The data are given in Table 8.

It was realized that a fair comparison of the two cultures (A_4 and E_3) was not possible, as they were both under the same concentration. The data in Table 7 show that, while concentration 0.098 gram-molecule was somewhat too strong for E_3, yet it was too weak for culture A_4. To make a logical comparison these two cultures were tried again. The E_3 had the concentration as shown best in Table 7, and A_4 had two concentrations; namely, the best and highest ever tried and another

TABLE 8.—*Comparative rate of daily absorption of a 3-salt culture solution and a 4-salt culture solution of equal molecular concentration.*

[0.098 gram-molecule (of all salts taken together) per liter.]

Date of observation.	Root 1.		Root 2.	
	Culture A_4.	Culture E_3.	Culture A_4.	Culture E_3.
	g.	*g.*	*g.*	*g.*
September 30	----------	0.910	0.275	--------
October 1	0.980	----------	----------	0.250
October 2	----------	0.575	0.445	--------
October 3	0.460	----------	----------	0.105
October 4	----------	0.965	0.470	--------
October 5	1.565	----------	----------	0.290
October 6	----------	0.405	0.420	--------
October 7	0.475	----------	----------	0.570
Average daily	0.870	0.713	0.352	0.303

a little stronger. The results from these cultures together with their respective molecular concentrations are given in Table 9.

Culture solution A_4 of the 4-salt type was found to be more readily absorbed than was culture solution E_3 of the 3-salt type. The A_4 was then selected for hourly absorption tests. As shown in Table 10 this set of tests was begun at 6.00 p. m. and ended at 6.00 p. m., twenty-four hours later. The results of the experiments together with data on weather during the period of observation are indicated in Table 10.

DISCUSSION OF RESULTS

EXPERIMENTAL DIFFICULTIES AND HOW THEY WERE MET

Few cultures in a set; variation in roots.—The variation in the roots and the small number of cultures in a set would have presented real experimental difficulties and sources of error were it not for the fact that the culture tests were run in a system of cycles. With this arrangement it was possible to test every root with every culture solution in a set. The first set contained data from eight cycles, while twelve cycles were made for the second set. In other words, sixty-four culture tests were made with the 3-salt type, and with the 4-salt type there were one hundred forty-four tests. Hence, the results in terms of averages are valuable and conclusive.

Climatic fluctuations.—The fluctuations of certain climatic factors, such as rainfall, temperature, and others, might also interfere with the uniformity of results to be obtained from two or more similar culture tests in the different cycles; but

TABLE 9.—*Comparative rate of absorption of two best culture solutions with the most suitable concentration found.*

[Culture A_4 was tried in two concentrations.]

Date.	Solution tested.	Root 1.	Root 2.	Root 3.	Root 4.	Root 5.	Root 6.	Root 7.	Root 8.	Root 9.	Average daily absorption of each of the culture solutions.		
											A_4 (0.1536).	A_4 (0.1152).	E_3 (0.0490).
		g.	g.	g.	g.	g.	g.	g.	g.	g.	g.	g.	g.
February 23	A_4(0.1536)	1.025			0.495			0.055			0.525		
Do	A_4(0.1152)		0.855			0.425			0.115			0.465	
Do	E_3(0.0490)			0.155			0.285			0.350			0.263
February 24	A_4(0.1536)		0.435			0.475			0.700		0.534		
Do	A_4(0.1152)			0.205			0.290			0.420		0.305	
Do	E_3(0.0490)	0.610			0.160			0.120					0.296
February 25	A_4(0.1536)			0.260			0.420			0.490	0.390		
Do	A_4(0.1152)	0.590						0.165				0.377	
Do	E_3(0.0490)		0.490						0.170				0.220
February 26	A_4(0.1536)	3.080			0.465			0.280			1.275		
Do	A_4(0.1152)		0.925			0.780			0.540			0.748	
Do	E_3(0.0490)			0.255			0.705			0.260			0.406
Average per day											0.546	0.476	0.296

TABLE 10.—*Hourly absorption of a culture solution* (A_4) *of the 4-salt type in milligrams.*

[Total concentration of 0.1152 gram-molecule of all salts taken together.]

Time.	Absorption.				Average absorption.	Temperature.	Weather observation.
	Root 1.	Root 2.	Root 3.	Root 4.			
October 7.	*mg.*	*mg.*	*mg.*	*mg.*	*mg.*	°*C.*	
6 to 7 p. m	60	35	45	55	48.75	26	Calm, little shower.
7 to 8 p. m	30	20	35	45	32.50	25	Calm.
8 to 9 p. m	40	20	35	30	31.25	24	Slight breeze.
9 to 10 p. m	50	15	25	25	28.75	24	Calm.
10 to 11 p. m	60	20	45	10	33.75	24	Slight breeze (10.45).
11 p. m. to 12 midnight	15	15	35	20	21.25	24	Slight breeze (11.45).
October 8.							
12 midnight to 1 a. m	45	15	25	50	33.75	24	Slight breeze.
1 to 2 a. m	35	15	35	25	23.25	24	Slight breeze (1.45).
2 to 3 a. m	20	15	25	20	20.00	23.5	Calm.
3 to 4 a. m	10	10	10	20	12.50	24	Do.
4 to 5 a. m	20	10	20	10	15.00	24	Do.
5 to 6 a. m	15	5	35	35	22.50	23.5	Do.
6 to 7 a. m	20	10	30	50	29.50	27.5	Calm, diffused light.
7 to 8 a. m	35	20	30	75	40.00	29	Sunny.
8 to 9 a. m	60	25	45	80	52.50	29.5	Diffused light, light breeze.
9 to 10 a. m	70	35	65	80	62.50	31	Shiny, little diffused light.
10 to 11 a. m	70	55	70	90	71.25	28.5	Light breeze, shower, sunny.
11 a. m. to 12 noon	55	55	75	70	63.75	31	Diffused light.
12 noon to 1 p. m	90	70	65	60	71.25	28.5	Shower, shiny, light breeze.
1 to 2 p. m	90	95	105	100	97.50	28.5	Sunny, light breeze.
2 to 3 p. m	75	80	95	90	85.00	28	Cloudy, windy.
3 to 4 p. m	20	20	60	50	37.50	27.5	Shower, cloudy.
4 to 5 p. m	70	45	55	60	57.50	27.5	Cloudy, calm.
5 to 6 p. m	65	40	45	50	50.00	27	Do.
Total	1,120	745	1,110	1,200	1,016.25		
Average absorption per hour					42.34		

care was taken to subject all the cultures in a cycle to the same set of climatic conditions. Hence, the results from the tests, especially when expressed in averages, are satisfactory and valuable.

Rapid absorption not always most beneficial to plants.—Investigators (5, 4) working on salt requirements of plants found that, in some cases but not always, the concentration is correlated with the rate of absorption. That is, the rate of absorption of a culture solution by the roots of higher plants decreases as the concentration is increased, or vice versa. The same investigators found that there is a concentration optimum for the plant and any alteration of this concentration was always followed by a corresponding decrease in growth or development of the plant. However, it was found that a concentration weaker than that of the optimum was always followed by increased absorption and transpiration, but somehow the plant remained undernourished. A question may therefore be raised as to whether or not the most rapid absorption observed in the present study can be expected to give a corresponding most beneficial effect to the coco palm.

The culture solutions indicated in Table 1 or those in Table 2 were different from one another only in the molecular proportions of the constituent salts, but the same in molecular concentration; therefore, the solution most readily absorbed supplied to the coconut tree the largest number of the molecules of the solutes. This is in accord with Avogadro's law. Hence, such a solution should be preferred. In this study this point of view is entertained.

COMPARATIVE MERITS OF 3-SALT AND 4-SALT CULTURE

Tests on salt molecular proportions.—The mass of data on hand, which are summarized in Tables 3 to 6, inclusive, plainly show that the rate of absorption of the culture solutions tested both in the 3-salt and in the 4-salt type varies according to the molecular proportion of the salts. These tables show that E_3 was almost always the best in the lot. However, the records on average daily absorption for the 3-salt type shown in Table 7 point to culture solution G_3 as being better than E_3. This is so because these two cultures were not tried on the same tree. The superiority of G_3 over E_3 might have been due to differences in vigor of the two trees. In Table 4, however, culture solution E_3 was almost as good as G_3, and the data on the relative rate of absorption of culture solutions (averaged from eight roots per day) as shown in fig. 1 give E_3 as more readily absorbed than G_3.

The data in Tables 5 and 6 obtained from the 4-salt set show that culture solutions A_4, B_4, and E_4 gave the best results of

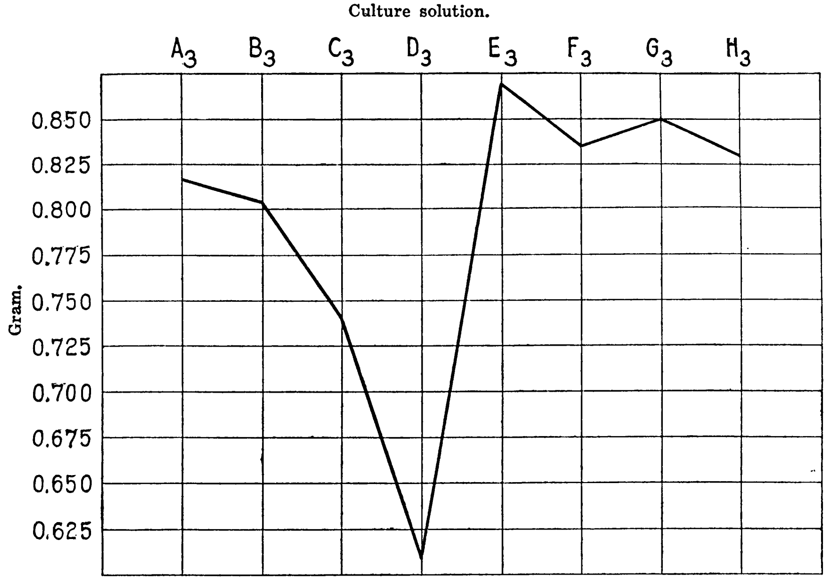


FIG. 1. Showing relative rate of absorption of culture solutions, averaged from eight roots per day.

the lot. In terms of relative rate of absorption (averaged from twelve roots per day) fig. 2 also indicates that these solutions are characterized by having low molecular proportions of monopotassium phosphate and of ammonium sulphate, low to medium content of calcium nitrate, and high to medium content of

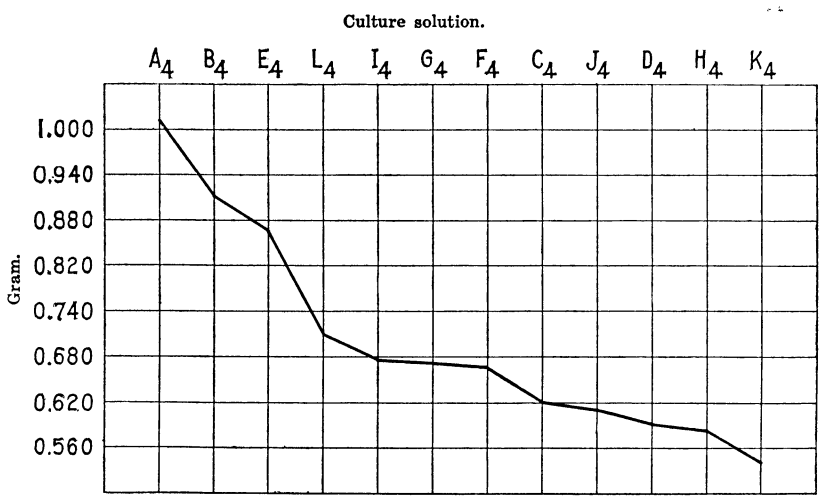


FIG. 2. Showing relative average rate of absorption of culture solutions by twelve roots per day.

magnesium sulphate. Therefore, it appears that the molecular proportion of the salts in the solutions that gave good results on young lowland rice plant (variety Wateribune) (4) also gave a similar beneficial effect to the coco palm. However, the coconut tree seems to require a more concentrated solution than that which was best for the rice plant.

Further tests.—The data in Table 7, which were intended for tests on concentrations, also seem to show the superiority of the 4-salt culture solution A_4 over any other solution of that type. It was also better than any one of the 3-salt type tested.

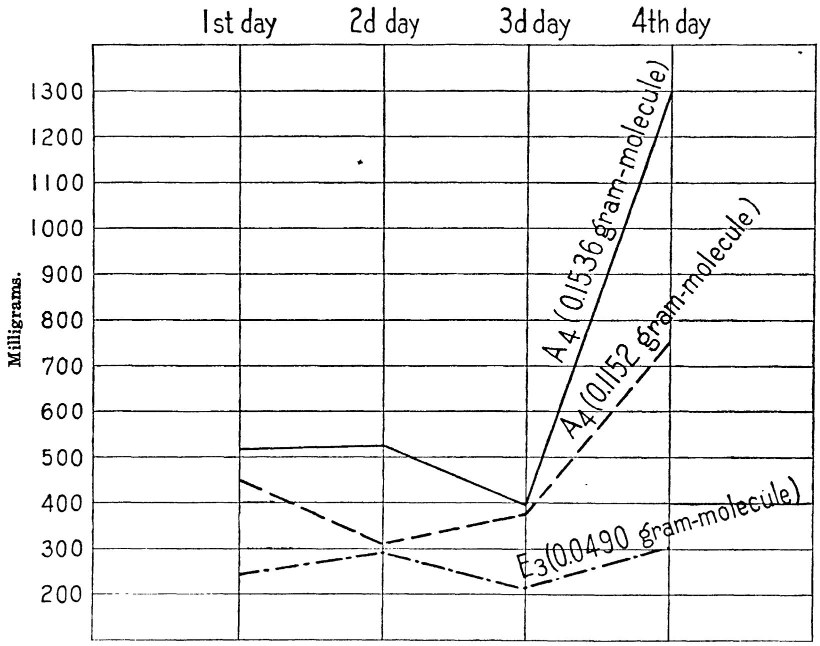


FIG. 3. Showing the superiority of A_4 over E_3. The graphs are built from the data in Table 8.

The data in Tables 8 and 9 plainly show also the superiority of A_4 over E_3; this superiority is graphically demonstrated in fig. 3 and fully confirms the results obtained by Bacomo, (1) in which he observed a rapid growth of coco seedlings following an application of sulphate of ammonia to the soil where the plants were growing.

Influence on rate of absorption by concentration.—The graphs in fig. 4 which are built out of the data in Table 7 conclusively demonstrate that the best concentration (0.049 gram-molecule) in the 3-salt type was much weaker than the best concentration

(0.1152 gram-molecule) in the 4-salt type. That a decrease or an increase in concentration of either of the two 3-salt cultures tested was accompanied by a corresponding decrease in the rate of absorption is also well shown in fig. 4. With the 4-salt culture solutions, however, the concentration that can very well be called optimum for the coco palm has probably not been found; for the strongest concentration of the best culture solution A_4 gave the highest records on absorption. The data in Table 9 as well as the graphs in fig. 4 confirm this statement. Further

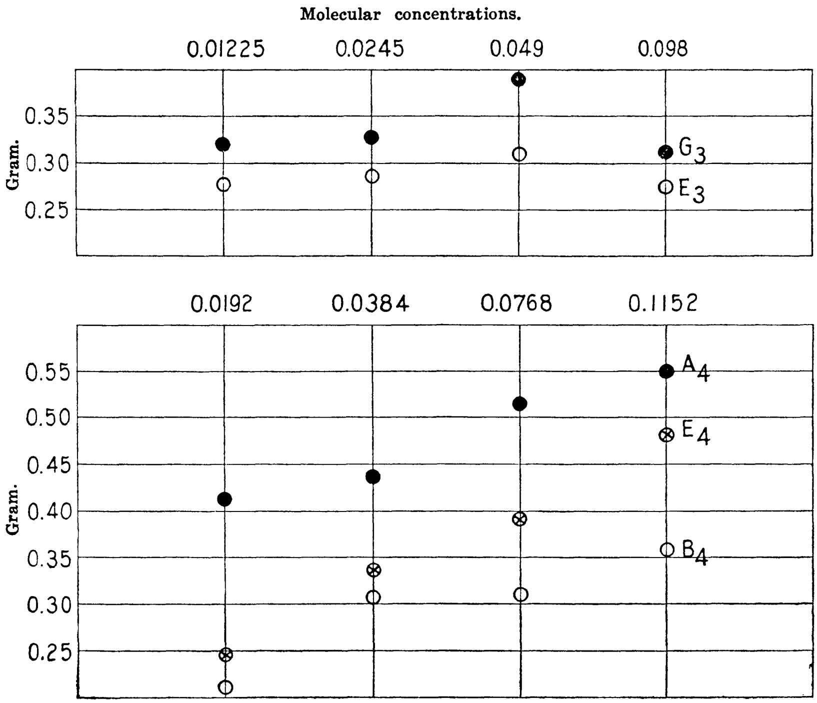


FIG. 4. Showing rate (average) of absorption of each of the 3-salt and 4-salt culture solutions in different concentrations. Data from Table 7.

investigation on this matter should be directed to the determination of the concentration of culture A_4 that can be considered optimum for this plant.

FLUCTUATIONS OF ABSORPTION

It is a well-known fact that processes occurring in the plant body naturally vary or fluctuate in rate from time to time. The rate of absorption of a culture solution by coco-palm roots is not an exception to this rule. It depends upon two sets of

conditions; those that occur inside and those that occur outside of the body of the plant. Among the important determining factors are the age and the health of the plant, its transpiring power, and transpiration. The last, in turn, depends upon the temperature of the air, humidity of the air, rain, wind velocity, and other factors. So, the rate of absorption indirectly depends upon the factors of weather just mentioned. Most of these factors naturally vary from hour to hour so that the record of absorption as here observed also fluctuated. The data in Table 10, which are graphed in fig. 5, bear this out. In this figure the

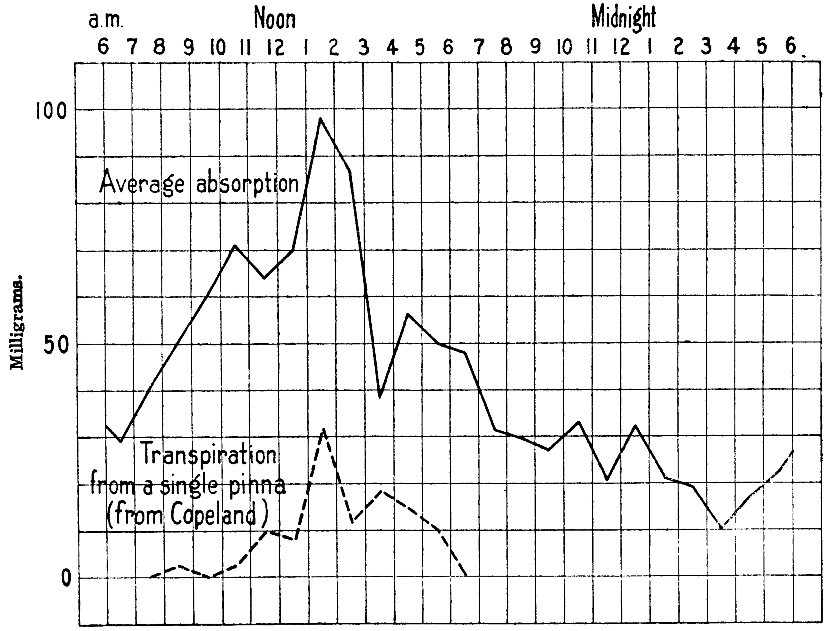


FIG. 5. Showing average absorption by the four roots and transpiration from a single pinna as observed by Copeland.

records on transpiration obtained by Copeland(3) are also graphed for comparison. It should be admitted that for details the data on absorption and those for transpiration are not quite comparable, for they were taken at different times and not from the same tree. However, in one way comparison may be permissible, because the curves in fig. 5 represent what might be considered normal[2] absorption and normal transpiration.

[2] Normal refers to rate of transpiration or absorption observed during the ordinary or usual conditions of weather.

Judging from the general appearance of the curves it will be quite safe to say that there is a very close correlation between absorption and transpiration. This is to be expected, as the coco tree is known to possess no tissue or organ for water storage. So that, if transpiration is increased (provided other conditions are normal), absorption is also most likely to increase, or vice versa. The most rapid absorption took place during the first two or three hours after noontime. Copeland found these hours also the most favorable for rapid transpiration. As shown in Table 10, the average absorption per hour by a single root was 42.3 milligrams of solution A_4. This average is for the entire twenty-four hours. If night hours were to be excluded a much higher figure would be obtained. The highest record shown in this table is 97.5 milligrams per hour per root. Even assuming that a full-grown coco palm has 8,000 roots, the total absorption of a complete solution A_4 in a day by a tree would be only 18.73 liters. A more reliable record, however, would be about 16 liters. The computation, as Copeland made it, is based on 6,000 roots to a full-grown coco palm.

However, Copeland obtained a higher rate of absorption than this. From the conclusion derived from his results, Copeland reports that a coco palm can absorb 24 liters (computed) of water every day. Therefore, there is a discrepancy of about 6 liters. This discrepancy is somewhat hard to account for. It might be due to difference in the trees used, to location of the plantations, or to the kind of solution. The first two conditions could not be duplicated here, but the last was possible.

On November 26, 1922, at 6 a. m., 0.1 normal potassium nitrate solution was supplied to four roots of a coco palm. The results obtained are recorded in Table 11.

TABLE 11.—*Absorption of potassium nitrate solution by four roots of a coco palm.*

Root No.	November 26.		November 27.
	12 noon.	6 p. m.	
	g.	*g.*	*g.*
I	0.565	0.570	0.250
II	0.900	1.240	0.195
III	0.650	1.250	1.100
IV	0.735	1.085	0.200

Rain fell during the night of November 26. This was responsible for the low absorption on November 27.

Considering the absorption during the first twelve hours, we find that each root absorbed an average of 1.749 grams of the solution. This rate will give us about 3.6 grams for twenty-four hours, if it is to be assumed (although incorrectly) that the rate of absorption during the night hours and during the day hours was the same. Assuming further that a coco palm has 6,000 roots, then the total amount of the solution to be absorbed would be 21.6 liters; if 8,000 roots, the absorption by the tree in one day would be 28.8 liters. It appears that the single-salt solution (KNO_3) was more readily absorbed than was the 3-salt or the 4-salt culture solution. However, as was pointed out, it should be admitted that except in a well-balanced complete culture solution rapid absorption can never offer a maximum beneficial effect to the plant. Therefore, the 0.1 normal solution of potassium nitrate, although apparently more readily absorbed than was the complete solution A_4, cannot supply the plant with all the elements essential for its normal development, as the latter (A_4) does. Hence, hereafter 16 liters instead of 24 should be considered as the most likely maximum absorption of a complete solution in one day by a fairly good-sized full-grown coco palm.

Although all the factors in the environments of the coco palm have more or less a direct influence on absorption of solution by roots, nevertheless the data on hand seem to show that the so-called evaporating power of air plays the most important rôle. This one factor, although comparatively new to the science of plant physiology, is recognized as being very significant. It is the expression of the sum total of all other factors tending to promote the evaporation of water from a free surface or from the body of the plant.

As shown in fig. 6, the curve for the evaporating power of the air found by Trelease(10) agrees fairly with the curve of average hourly absorption of solution by the roots. This suggests that, provided soil moisture is abundant, the growing of the palm should prove successful, even in places where the drying influence of the air is great. Hitherto the palm has been generally grown in places where drought or a pronounced dry season does not exist, but the fact just brought out seems to confirm the belief of many interested in coconuts, that irrigation should be resorted to in time of drought.

The graphs in fig. 6 further show that the rate of absorption is in inverse ratio to the apparent pinna width. Therefore, the

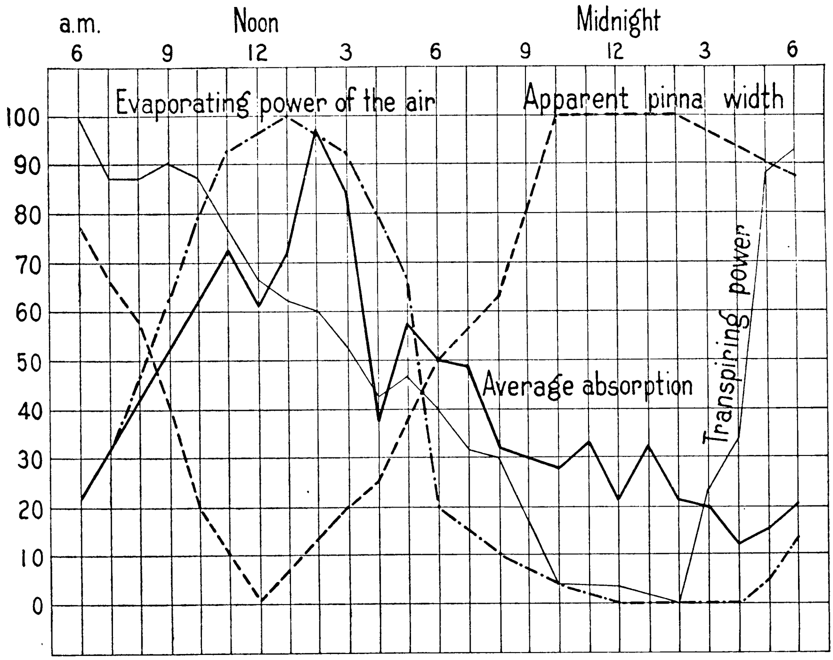


FIG. 6. Showing the transpiring power, apparent pinna width, and evaporating power of the air, as obtained by Trelease, and average hourly absorption from four roots.

latter might be employed in rough determination of the rate of absorption. A wide-open pinna would indicate that water or mineral solution is rapidly entering the root, or vice versa. However, precautions should be observed to make the interpretation only when several apparent pinna-width readings shall have been made, for it is somewhat evident that one or two hourly readings may not be sufficient.

The influence of environment on absorption may further be seen from the data given below, taken from the mass of data or figures collected during the progress of this study. The conditions of weather observed are given briefly in Table 12.

TABLE 12.—*Conditions of weather.*

Factor observed.	Rainless days.	Days with rain.
Date of observation	February 8 to 26	November 9 to 27.
Rainfall	None	572.3 millimeters.
Wind velocity	3.79 miles per hour	3.39 miles per hour.
Cloudy days	4.5	13.5.
Evaporating power of air	226.0 cubic centimeters	55.7 cubic centimeters.
Insolation	86.6 cubic centimeters	8.5 cubic centimeters.
Mean temperature of air	26.6° C.	25.5° C.

The records on absorption are as shown in Table 13.

TABLE 13.—*Absorption on rainless and on rainy days.*

RAINLESS DAYS.

	February						Average absorption per root per day.
	8-11	11-14	14-17	17-20	20-23	23-26	
	g.	*g.*	*g.*	*g.*	*g.*	*g.*	*g.*
Absorbed by 12 roots	30.8	50.3	32.8	35.8	35.9	34.9	
Average per root	2.6	4.2	2.7	3.0	3.0	2.9	1.0

RAINY DAYS.

	November						Average absorption per root per day.
	9-12	12-15	15-18	18-21	21-24	24-27	
	g.	*g.*	*g.*	*g.*	*g.*	*g.*	*g.*
Absorbed by 12 roots	7.9	10.4	9.1	11.1	10.8	9.3	
Average per root	0.7	0.9	0.8	0.9	0.9	0.8	0.3

The last column of figures shows that the rate of absorption was 233.33 per cent more rapid during rainless days than during rainy days. As a rule, rainless and sunny days are followed by a clear sky, greater evaporating power of the air and of the sun, and a higher mean temperature of the air. Collectively, these factors were responsible for a more rapid absorption of the solution by the roots. Rain is, of course, needed to supply water to the roots, but in the present study water or solution for the roots was well supplied. The rôle that rain played in these experiments was to increase the humidity of the air. This, in turn, decreased the evaporating power of the air, which was largely responsible for rapid transpiration. Rapid transpiration, as certain graphs in fig. 6 show, is usually accompanied by a corresponding rapid absorption.

SUMMARY AND CONCLUSIONS

From the extensive mass of data on the absorption of salt solutions by the roots of the coco palm, and under the conditions of this study, it appears that the following generalizations may be made:

1. That, as was expected, the rate of absorption of the 3-salt and the 4-salt culture solutions varied according to the molecular proportions of the salts.

2. That the most rapid absorption of a complete culture solution from the 3-salt and the 4-salt types supplied to the coconut tree the largest number of molecules of the solutes. This is in accordance with Avogadro's law.

3. That the best culture solution (A_4) found had a concentration of 0.1536 gram-molecule (of all the salts taken together) per liter and was characterized by 1 part, each, of ammonium sulphate, monopotassium phosphate, and calcium nitrate, and 5 parts of magnesium sulphate. A similar culture solution but in much weaker concentration was also found by Espino(4) as good for the young rice plant.

4. That culture solution A_4 had ammonium sulphate in addition to the other three salts in E_3, the best in the 3-salt type. This difference may suggest that the addition of ammonium sulphate was responsible for the rapid absorption. It may suggest further, as Bacomo(1) found, that the plant is benefited by an application of the substance.

5. That the rate of absorption of A_4 gradually increased from the morning hours to between one and two o'clock in the afternoon. Thence, a gradual decrease was observed, with slight fluctuations, until early the next morning. This form of curve corresponds fairly well with the records of Copeland for transpiration of the pinna of the same plant. It is suggested, therefore, in the case of this plant, that transpiration may serve as an index of absorption, or vice versa.

6. That the apparent pinna width may also serve as a rough index of the rate of absorption. Contrary to expectation and under normal conditions, rapid absorption takes place when the pinna is somewhat closed. However, in one way this should really be expected, as there is an apparent deficit in water in the leaf when the latter is closed.

7. That the evaporating power of the air appears to be directly proportional to absorption. This fact may suggest the possibility of successful cultivation of the coco palm even in places where the drying power of the air is great, provided that soil moisture is liberally supplied.

8. That the rate of absorption during a period of sunny days was about 233 per cent (average) more rapid than during a period of rainy days. This was really to be expected, but a quantitative comparison has never hitherto been made.

9. That an absorption of 24 liters (computed) by a full-grown coco palm in one day, as reported by Copeland, was based

on the data of absorption of potassium nitrate, a solution that does not supply all the elements essential for normal growth, which elements the plant usually derives from the soil. The maximum absorption (computed) by a tree in one day, of the best complete culture solution tested, appears to be 16 liters only.

BIBLIOGRAPHY

1. BACOMO, P. V. Observation on coconut seedlings. Philip. Agr. and Forester **5** (1917) 303–310.
2. COPELAND, E. B. On the water relations of the coconut palm (Cocos nucifera). Philip. Journ. Sci. **1** (1906) 12–17.
3. COPELAND, E. B. The Coconut. Macmillan and Co., London (1921) 225.
4. ESPINO, R. B. Some aspects of the salt requirements of young rice plants. Philip. Journ. Sci. **16** (1920) 455–525.
5. HOAGLAND, D. R. Relation of the concentration and reaction of the nutrient medium to the growth and absorption of the plant. Journ. Agr. Res. **18** (1919) 90.
6. OSTERHOUT, W. J. V. The antitoxic action of magnesium and potassium. Bot. Gaz. **45** (1908) 117–124.
7. SHIVE, J. W. A study of physiological balance for buckwheat grown in three-salt solutions. Bull. New Jersey Agr. Exp. Sta. **139** (1917) 5–63.
8. SHIVE, J. W., ET AL. A comparative study of salt requirement for young and mature buckwheat plants. Journ. Agr. Res. **14** (1918) 151–175.
9. TOTTINGHAM, WM. E. A quantitative chemical and physiological study of nutrient solutions for plant cultures. Physiol. Res. **1** (1914) 133–245.
10. TRELEASE, S. F. Foliar transpiring power of the coconut. Philip. Journ. Sci. **20** (1922) 167–176.

ILLUSTRATIONS

TEXT FIGURES

NOTES ON JAPANESE LEPIDOPTERA AND THEIR LARVÆ: PART VII

By A. E. WILEMAN
Of Dorking, England

TWO COLORED PLATES

HETEROCERA

CERURIDÆ

Genus **FENTONIA** Butler

Fentonia BUTLER, Trans. Ent. Soc. London (1881) 20.

Fentonia ocypete Bremer.

Plate 1, fig. 1, larva; fig. 2, food plant. Larva of *Fentonia ocypete* forma *japonica* Grünberg.

Japanese name, *hosoba-shachihoko.*

Harpyia ocypete BREMER, Bull. Acad. Pétersb. (1861) 481 (=*lævis* Butler); Lep. Ost-Sib. (1864) 44, pl. 5, fig. 1, ♂; OBERTHÜR, Étud. d'Ent. 5 (1880) 60, pl. 8, fig. 6, ♂; LEECH, Proc. Zool. Soc. London (1888) 644, No. 308; HAMPSON, Moths Brit. India 1 (1892) 148; KIRBY, Cat. Lep. Het. (1892) 562; STAUDINGER, Rom. Mém. Lép. 6 (1892) 343; LEECH, Trans. Ent. Soc. London (1898) 304, No. 117; STAUDINGER and REBEL, Cat. Lep. Pal. I (1901) 107, No. 790; MATSUMURA, Cat. Insect. Jap. 1 (1905) 35, No. 280; Thousand Insects of Japan [Zoku Nihon Senchū Dzukai (Jap.)] (1909) Suppl. 1, 69, No. 118, pl. 11, fig. 1, ♀; GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 291, pl. 45*b*, ♂; MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 314, No. 54, pl. 23, fig. 8, imago; fig. 27, larva; fig. 28, cocoon; fig. 29, pupa; pl. 27, fig. 2; pl. 29, fig. 3; pl. 33, fig. 7; text-figs. 19, 20.

Fentonia lævis BUTLER, Trans. Ent. Soc. London (1881) 20; Cist. Ent. 3 (1885) 129.

Fentonia ocypete forma *japonica* GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 292, pl. 45*b*, ♀; MATSUMURA, Ōyō Konchūgaku [Practical Entomology] ed. 2 (1920) 712 (Jap.).

The larva figured (Plate 1, fig. 1) was taken in September, 1900 (figured, September 22), at Yoshino, Yamato Province, Honshu, on dwarf oak, Japanese name, *kunugi* (*Quercus serrata* Thunberg). This larva died, and I failed to breed the imago; but I have bred imagoes of *F. ocypete* from similar larvæ on

several occasions at Tokyo, Honshu. I identified these specimens at the British Museum (Natural History) in 1909 as *F. ocypete* Bremer=*lævis* Butler, but they are referable to the form *japonica* Grünberg described in 1912.

Grünberg [1] remarks:

> The Japanese specimens evidently belong to a special form, which we call japonica *form. nov.* (45b). The markings are somewhat less prominent, the black streak on the median vein is absent, likewise the light brown colouring, which is replaced by a band-like, light grey, median area reaching from first double line to the apex of the cell.

I describe the larva from my artist's original figure as follows:

Larva.—Length, about 39 millimeters. Head grayish, marbled with dark streaks; thoracic segments light greenish yellow; two violet-brown mediodorsal spots on segment 2 (counting head as segment 1); a violet-brown mediodorsal bar lined with white continues from these spots as far as segment 4; the bar is broad at each extremity and attenuated in the center, being shaped somewhat like a dumb-bell; from segment 4 to anus the color is, more or less, violet-white, tinged dorsally here and there with yellow and streaked with faint, violet lines and small, yellow patches, the latter being more prominent dorsally on the posterior segments; on segment 6 there commences a broad, violet-brown, arrow-shaped, mediodorsal bar which radiates at the base on both sides laterad; the arrowhead is centered with a yellow, diamond-shaped mark; the violet lines and yellow patches form a definite mediodorsal pattern on the posterior segments.

The larva feeds on the two dwarf oaks, Japanese names, *ko-nara* and *kunugi* (*Quercus glandulifera* Blume and *Q. serrata* Thunberg). It is an example of procryptic colors affording general protective resemblance. This is defined by Poulton [2] as "concealment as a protection against enemies, effected by colors which harmonize with the total artistic effects of the immediate environment." It generally rests at full length on the edge of a leaf when feeding and eats right through to the midrib. When stretched out in this manner its presence is very difficult to detect as the position in which the larva places itself gives it the irregular outline of the faded edge of a leaf

[1] Seitz's Macrolep. Faun. Pal. 2 (1912) 292.

[2] Vide Philip. Journ. Sci. § D 9 (1914), Table 1, facing page 248.

still tinged with a little green. The posterior segments represent the faded part of the edge and the green thoracic segments represent the tinge of green in the leaf.[3]

Local distribution.—Honshu, Musashi Province, Yokohama (*Pryer*); Tokyo, bred, June (*Wileman*): Shinano Province, Oiwake (*Pryer*): Yamato Province, Yoshino, May, June, August, September (*Wileman*): Shimotsuke Province, Nikko, July (*Wileman*). Kyushu, Bungo Province, Usuki (*Marumo*). Matsumura records this species from Honshu and Hokkaido.

Time of appearance.—Larva, August, September, October; imago, May to September. There are probably two broods each year according to Hirayama.[4]

General distribution.—Eastern Siberia, Amurland; Korea; Japan; northern India, Simla (*Grünberg*); Manchuria (*Matsumura*). Bremer's type of *F. ocypete* is from Ussuri, eastern Siberia, June (*Maack*). Butler's male type of *F. lævis* is from Yokohama (*Pryer*). There is only one male specimen of this species from India in the British Museum (Natural History); all the remaining specimens are from Japan. The Indian specimen comes from Sabathu, near Simla (about 4,000 feet), ex Harford collection. The series in the British Museum consists of four males and three females.

Genus **CERURA** Schrank

Cerura SCHRANK, Fauna Boica 2, 2 Abth. (1802) 155.

Cerura milhauseri Fabricius.

Plate 1, fig. 3, larva;[5] fig. 4, food plant. In the British Museum (Natural History) this species is placed in the genus *Cerura*.

Japanese name, *gin-shachihoko*.

Bombyx milhauseri FABRICIUS, Syst. Ent. (1775) 577 (=*terrifica* Schiffermüller); SEPP, Beschouwing der Wond. Gods. 5 (1836) 149, pl. 39, figs. 1–2, larva; fig. 3, cocoon; fig. 4, pupa; fig. 5, imago ♂; fig. 6, imago ♀; LEECH, Proc. Zool. Soc. London (1888) 641, No. 288; KIRBY, Cat. Lep. Het. (1892) 595; LEECH, Trans. Ent. Soc. London (1898) 309, No. 128; STAUDINGER and REBEL, Cat. Lep.

[3] *Cerura milhauseri* Fabricius is another example of this protective resemblance, vide footnote 13.

[4] Marumo, Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 315.

[5] I failed to breed an imago from this larva so am unable to say whether it would have developed into typical *milhauseri* Fabricius or variety *umbrosa* Staudinger, but, as will be seen further on, the type *milhauseri* is, in Gifu, Mino Province, commoner than the "East Asiatic form," variety *umbrosa*.

Pal. 1 (1901) 107, No. 791; HOFMANN, Gross-schmett. Eur. Ed. A. Spuler 1 (1901–1910) 93; 3 (1908) pl. 22, fig. 4, imago ♂; 4 (1910) pl. 19, fig. 19a, larva; Schl. taf. fig. 49, ovum; BERGE, Schmett. Buch. (Rebel) (1910) 103, No. 245, pl. 22, fig. 14*b*, imago ♂; fig. 14*a*, larva; GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 292, pl. 45*a*, ♂, ♀; NAGANO, Nawa's Insect World [Konchū Sekai (Jap.)] 20 (1916) 7, pl. 1, figs. 1–13, larva, pupa, imago ♂, ♀; MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 296, No. 25, pl. 22, fig. 7, imago; pl. 27, figs. 11, 14; pl. 36, fig. 1; text-fig. 6.

Bombyx terrifica DENIS and SCHIFFERMÜLLER, Schmett. Wien (1775) 63; HÜBNER, Bomb. (1800) pl. 8, figs. 32, 33.

Hybocampa milhauseri var. *umbrosa* STAUDINGER, Rom. Mém. Lép. 6 (1892) 343; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 107, No. 791*a;* MATSUMURA, Cat. Insect. Jap. 1 (1905) 35, No. 281; Thousand Insects of Japan [Zoku Nihon Senchū Dzukai (Jap.)], suppl. 1, 74, No. 126, pl. 11, fig. 9 ♀; GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 292, pl. 45*a*, ♀; MATSUMURA, Ōyō Konchūgaku [Practical Entomology] ed. 2 (1920) 713, pl. 45, fig. 5, imago; fig. 5*a*, larva; fig. 5*b*, pupa [Jap.].

The larva figured (Plate 1, fig. 3) was taken in October, 1900 (figured, October 27), at Yoshino, Yamato Province, on dwarf oak, Japanese name, *kunugi* (*Quercus serrata* Thunberg). This larva died, and I failed to breed the imago. However, I bred a female of the so-called east Asiatic and Japanese form *Cerura umbrosa* Staudinger from a similar larva on June 6, 1894.

Grünberg [6] places *Cerura milhauseri* Fabricius and the form *umbrosa* Staudinger in the genus *Hoplitis* Hübner (=*Hybocampa* Lederer), which is preoccupied in Hymenoptera, Klug, 1897, and he describes the larva of the genus *Hoplitis* as follows:

Larva almost naked, only clothed with very short, thin, but rather dense hair, with 14 feet, the head large, flat, incised above and having a rounded-rectangular outline. Thoracical segment 1 with 2 short obtuse, lateral tubercules, abdominal segments 1–6 each with a dorsal process ending in a sharp point, which is directed anad, the anterior process of considerable length, with forked tip, the following ones decreasing in size, on segment 8 a large vertical dorsal process with sharp point, as well as 2 small lateral ones with the point directed backwards; the anal feet replaced by 2 very short points. Pupa short and stout, the anal end broadly rounded, vertex with a short pointed tubercle which is employed in opening the cocoon. The latter oval, flat, of the grey colouring of the tree-trunk to which it is fastened.[7]—Only one species is known of this genus [namely, *Hoplitis milhauseri*].

[6] Seitz's Macrolep. Faun. Pal. 2 (1912) 292.

[7] Esper says the larva spins between leaves, but that its usual place is on the bark of the food tree like *Cerura*.—Esper 3 (1782) 108, pl. 21, fig. 1, larva; fig. 3, pupa; fig. 4, imago ♂; fig. 5, ♂ var.

Grünberg [8] describes the larva of *Hoplitis* [=*Cerura*] *milhauseri* Fabricius as follows:

Larva pale yellowish green, minutely dotted with red, abdominal segments 3–7 with whitish red lateral markings and red tubercles. When at rest the apex of the abdomen is held erect. June to August on Oak, also on Elm, Poplar and Birch. Pupa dark brown. The flat cocoons, which are very difficult to perceive, are less hard than in *Cerura* and *Dicranura;* the cocoons are only easily found if they bear a hole, which is said to be made by a woodpecker having eaten the chrysalis; in many instances, however, the hole means simply the exit of the moth. The latter emerges in May or June, comes to the lamp, and rests by day about 1–2 yards above the ground on the trunks of old Oaks.

Kirby [9] gives a figure of the larva of *Hybocampa* [=*Cerura*] *milhauseri* Fabricius and describes it as follows:

Green, granulated with whitish with a broad pale brown stripe on the sides; there are small red points on the humps of segments 6 to 10, and a branch-like excrescence, divided above, on that of the 5th segment. It lives on oak in July and August, and the cocoons, which are very difficult to distinguish from the bark, are nearly always found hollowed out by woodpeckers.

Newman [10] also gives a figure of the larva of *Hoplitis terrifica* (not British) (=*milhauseri* Fabricius).

The following description of the larva of *Cerura milhauseri* Fabricius is based upon my artist's original figure and notes taken from two larvæ bred by me at Tokyo in September and October, 1893.

Larva.—Head light brown; body olive-green; on segment 2 (counting head as segment 1) there are two minute, subdorsal, brown tubercles, or warts; a medial, dorsal, longitudinal, white line from segment 2 to segment 4; a subdorsal, longitudinal white line on each side from segment 1 to segment 5 where it runs upward obliquely and joins the base of the dorsal process on segment 5; on segment 5 there is a long, mediodorsal, brownish white process armed with triple apical spines, two of which point anad, the third points cephalad; similar, but shorter, dorsal processes on segments 6 to 10, inclusive, and on segment 12, all armed with paired apical spines; the processes on segments 7, 8, and 12 are the longest, but not one of them is as long as the process on segment 5; a short minute spine at the lateral

[8] Loc. cit.

[9] European Butterflies and Moths (1889) 137, pl. 30, fig. 7*a* (larva).

[10] British Moths (1869) 203, fig. 7.

angle of the anal segment; all these processes and spines are curved anad; the anal claspers on segment 13 are absent and are replaced, above the anal flap, by two very short spinous points projecting outward; segments 6 and 7 mottled at the base of the dorsal process with small, irregular, brown spots and streaks on a whitish green ground which extends two-thirds of the way toward the spiracles; segment 8 dorsally dark, and laterally light brown, speckled with white dorsally; this brown color extends two-thirds of the way toward the spiracles and also extends dorsally to segments 7 and 9, giving the appearance of a lateral, triangular patch with its base resting dorsally on segments 7 to 9 and blunted at the apex; segment 9 laterally mottled with yellow which edges exteriorly the brown triangular patch; the posterior half of segment 9, also the succeeding segments to segment 13, mottled more or less, especially segments 10 and 13, with minute yellow spots; small brown patches at the base of the processes on segments 10 and 12 and a few brown streaks on segment 13; an irregular, whitish, longitudinal, spiracular stripe from segment 6 to segment 11, interrupted at segments 7 and 11; spiracles white, ringed exteriorly with brown; legs and prolegs green; the larva elevates the anal segments in the same way as *Stauropus fagi* Linnæus and other species of the same genus. A comparison of the description of the larva of *Hoplitis* [=*Cerura*] *milhauseri* given by Grünberg and of *Hybocampa* [=*Cerura*] *milhauseri* given by Kirby with my description of the larva shows the following differences:

Comparison of Grünberg's description: The larva of *umbrosa* is, I believe, naked, not "clothed with very short, thin, but rather dense hair." I did not, however, make any note on this point. The dorsal processes of "abdominal segments 1 to 6" (segments 5 to 10) do not, in my figure, "end in a sharp point which is directed anad," but in paired spines which are directed anad. The "anterior process" (segment 5) has a "forked tip" which is directed anad, but it also has a third spine directed cephalad which Grünberg does not mention. On "abdominal segment 8" (segment 12) there is not a "large, vertical process with a sharp point," but there is a process with paired spines which is much shorter than the process on segment 5 and is, apparently, not much longer than the processes on segments 7 and 8. The larva is not "minutely dotted with red," but is dotted with yellow on certain segments. Abdominal segments 3 to 7 are not "marked with whitish-red lateral markings and red tuber-

cles," but segments 6 to 9 (abdominal segments 2 to 5) are marked with an irregular, deep and pale brown patch and spots, and the spiracles are white, ringed exteriorly with brown. Grünberg states that A. Seitz found the larva of *Hoplitis* [= *Cerura*] *milhauseri* Fabricius on the cork tree [11] in northern Africa and that this larva differs from European ones in the tips of the processes being lemon yellow instead of red. Kirby calls these tips pink and says that the larva has a pale brown stripe on the sides. In my figure these tips are apparently brown, but I did not make any note on this point. Neither Grünberg nor Kirby mentions dorsal and subdorsal, white, longitudinal stripes on segments 2 to 5, nor a white spiracular stripe.

Pupa.—The pupa is inclosed in a hard, oval cocoon affixed to oak trunks. I have also observed that these cocoons are seldom to be found intact, but this may be caused either by the emergence of the moth or by birds. The species certainly is not common in Japan and possibly the attacks of birds have something to do with its rarity.

Nagano, in an article [12] on *Hoplitis milhauseri* Fabricius and its variety *umbrosa* Staudinger from which I have translated excerpts as follows, states that—

both typical *milhauseri* and the variety *umbrosa* occur in Japan. *Umbrosa*, which is usually regarded as the East Asiatic form of *milhauseri*, is generally of a darker colour and the hind wings are grey. * * * I have not bred this moth continuously throughout the year so cannot speak with absolute certainty regarding its life history. However, the year before last [1914] I captured twenty seven males at the electric light between June 3 and June 24 and eighteen males from August 8 to August 18. From this I infer that in the vicinity of Gifu this species must certainly be double brooded. The larvæ which I have observed, taking them in the foregoing sequence, are those corresponding to the second brood, namely, those seen from September to October. They feed on *kuri* [Spanish or sweet chestnut, *Castanea vulgaris* Lamarck var. *japonica* de Candolle], *kunugi* [dwarf oak, *Quercus serrata* Thunberg], but in Europe they are said to feed on *kashi* [oak, *Quercus* sp.], *nire* [elm, *Ulmus* sp.] *kabanoki* [birch, *Betulla* sp.], *yamanarashi* [aspen, *Populus tremula* Linnæus] and other trees. When full grown the larva generally fastens its flattened, oval, brown cocoon to the bark of a tree. The exterior of the cocoon is besprinkled with minute shreds of bark and lichen which so harmonise with the appearance of its environment that it is difficult to distinguish it. The pupa hibernates inside the cocoon and the imago emerges at the commencement of the following June

[11] The late Doctor Chapman says that he often found the empty cocoons on cork trees in the Riviera, southern France.

[12] Insect World [Konchū Sekai (Jap.)] 20 (1916) 7, pl. 1, figs. 1–13.

* * *. The curious shape of the larva is for purposes of protective resemblance.[13]

Furthermore, if the larva is viewed from behind, the dorsal portion of the last segment is flattened and ends in two spines which gives it a striking resemblance to the face of an animal. Whenever it raises this last segment, on being attacked by another creature, these spines look exactly like a swollen chin so that they evidently seem to be provided as a means of evading a rear attack * * *. The variety [*umbrosa*] which is regarded as the East Asiatic form occurs in Ussuri, China, Japan (Hokkaido, Honshu). * * * I do not regard the relations of the type and variety [*umbrosa*] as being of a local nature. At Gifu both can be taken together. There is one female specimen of the variety [*umbrosa*] among the specimens of this laboratory which was taken in the woods near the town of Gifu on August 22, 1890, but it was damaged at the time of the Great Earthquake and only the wings of one side and the body remain. This is, without any doubt, a specimen of *umbrosa*, and, up to now, was the only one to be found in our laboratory collection. Since the year before last [1914], however, we have been able to obtain many more specimens which have been attracted to our electric light, all these have proved to be *typical* specimens and the fact that we have never taken a single specimen of the variety [*umbrosa*] with them is exceedingly strange. It is however a fact that both type and variety occur together.

The following notes by Chapman [14] on *Hybocampa milhauseri* (=*Cerura milhauseri* Fabricius) are so interesting that I think it advisable to incorporate them in this paper:

Among my earliest entomological ambitions was a desire to become acquainted with this insect, my interest being, I think, excited by Sepp's figure of the larva, and the Vernacular name which he gives it, the "Dragon." It is now possible to purchase the insect alive, and I have thus been enabled to learn something of it, and I find it so remarkable in several particulars as to much more than justify my curiosity. It is not really closely related to any of our Notodontas, but is nearest to the Ceruras with a suspicion of true *Notodonta* (*N. ziczac* and *N. dromedarius*). The egg is large, clay coloured and beautifully zoned, with a dull terracotta like surface, apparently free from any structural lines or markings,—really the structure is so much finer than in *Cerura* that a much higher power is needed to show it,—of a form not very different from that of *C. vinula*. The egg of *C. erminea* is so different from that of *vinula* that it is, perhaps, not safe to say that that of *H. milhauseri* is not also of a *Cerura* pattern. * * *

The young larva has grand lateral horns in front and a dorsal row; as he grows older the lateral ones disappear whilst the dorsal ones remain,

[13] Vide Chapman, The Entomologist 23 (1890) 91 and 203. From the notes of Chapman and Nagano it appears that the larva enjoys the advantages afforded by procryptic coloration which gives it a special protective resemblance. Vide Philip. Journ. Sci. § D 9 (1914) Table 1, facing page 248.—A. E. W.

[14] The Entomologist 23 (1890) 91.

though proportionately smaller. I do not propose to describe the larva, which of course, is well known, and to which no description without a figure can do justice; but till I saw it alive I could not understand why any larva should have such remarkably angular outlines, curiously conspicuous corners and humps. What the dark young larva resembles I have not ascertained, but by chance I one day brought in with their food so exact a resemblance of the full-grown larva, that there could not be any doubt as to the meaning of all its curious outlines and markings. This was a curled oak leaf, eaten and abandoned by a *Tortrix* (*viridana* ?) larva.

This particular leaf was in detail exactly imitated by the larva of *H. milhauseri.* There was a curled portion of leaf with the outline of the body of the larva, the netted green texture of the leaf like the small markings on the surface of the larva, a brown decayed mark or two like the larva has; the extremity was eaten off on lines following partly a rib, so as to imitate the truncate aspect the larva has, however viewed; whilst the secondary ribs of the leaf, being eaten between projected laterally from the roll just like the dorsal spines of the larva, and in about the same size and order; the tall one in the 5th segment; the dwindling ones in the 6th to 10th; and the taller bifid one on the 12th; this one resembling points from both edges of the leaf. Most curious, perhaps, of all, the little backward projecting points at the tips of the spines (or humps), apparently so superfluously complicated in the larva, were exactly represented in the leaf; the *Tortrix* larva, in eating the substance of the leaf between the secondary ribs, had eaten these down to some extent also, but stuck fast just at a tertiary branch, the small remaining portion of which precisely represented the backward process of the larval spine. I never met with another rolled leaf that happened in exact number, size, and position, to represent all the processes of the larva as this one did, but any rolled and abandoned leaf bore a very close resemblance to the larva.

The cocoon is the most *Cerura*-like phase of this insect; it is made on the bark of the tree; though rather rounder and not quite so flat, it is in favorable specimens very like a *Cerura* in similar locality. It differs, however, in several particulars. In its construction the larva first makes a silken net over itself at the site of the cocoon; this is so open and flimsy looking, and so close down on the larva, which is rolled together under it, that it is surprising how the larva can move about inside to continue the work, and how in doing so it does not tear it all to pieces. *Cerura* on the other hand (I have watched *bifida* and *bicuspis*), selects a place for its cocoon, and begins at what will be the tail of the cocoon by making what looks like its head, a little structure like the toe of a slipper, it pushes this end forward, working beneath it by loosening its attachments in front and pushing its head under, spinning a continuation of it; in this way it gets under and detaches from the surface any bits of lichen and loose fragments of bark, which thus adhere in precisely their natural positions to the surface of the cocoon, and so much help its concealment; and having in this way pushed the front of the cocoon forward to its place, it closes the hinder end, and begins the excavating process by which it obtains the materials to form the outer part of the cocoon of a sort of artificial bark. *H. milhauseri* gets to the surface of the cocoon some colouring matters or lichenous material from the surface

of the bark, and puts a little detached material round the margin of the cocoon to make it fit a little; but the face of the cocoon, instead of being like that of *Cerura*, an artificial bark, is almost pure silk of a dense gummy substance, such as I have seen *vinula* make under difficulties when he could get no wood to work with. *Milhauseri* only slightly smooths the bark beneath the cocoon and covers it with gummy silk. *Cerura* lies in a neatly excavated cavity in the bark with practically no silken lining. Partly by its original close structure, and partly by contraction as it matures, this cocoon fits the pupa more closely than any other cocoon I have met with, so that, combined with its dense horny texture, it is extremely difficult to open it without injuring the contained pupa.

This close fitting of the cocoon to the pupa is related to perhaps the most curious of all the facts I have observed in this species, that is, its method of emergence; which is, I think, perhaps the most remarkable of any of the many remarkable provisions in different Lepidoptera for the escape of the moth from its cocoon.

As the shortest way of describing this process, I will call it cutting out a lid with a sardine opener.[15] Cerura bursts an irregular lid, having first softened the place with some fluid, and in many instances the broken lid falls back for a time into its place; the lid is irregular in form, often in several pieces, just as accident decides; but *milhauseri* marks out with his sardine-opener an exact definite lid, of which there is no trace or indication in the construction of the cocoon, and continues cutting on this exact line until the lid is set free. This lid is of oval shape, but with the anterior margin more rounded than the posterior. There is something more to be learnt about the action of this sardine-opener than I have yet ascertained, but I can give a few more particulars. First, as to the implement itself. In the pupa, just in front of the eyes and between the bases of the antennæ, is a deep pit, having at the bases of the antennæ, on either side, a sharp margin, almost a horn, stretching up from below; from the mouth region towards the pit, is a flat surface slightly furrowed and wrinkled, and terminating at the front margin of the deep pit (though one would say at first sight in the middle of it), in a straight spine projecting well beyond the general surface of the pupa, sharply pointed and polished; a slight ridge stretches back from the spine through the pit, and fades out on to the surface of the pupa, so that the pit might be described as a double furrow, stretching from before backwards. This spine is the sardine-opener, and by a lateral rotatory movement of the pupa which obtains its fulcrum from the tightness with which it is grasped by the cocoon, it traverses over and over again the outlines of the lid till it is cut through.

I have not seen this operation performed, for the reason that when you attempt to see it you stop it; but I have caught the creature actually at work, and can add this further fact, that the spine in some way

[15] The late Doctor Chapman in a letter addressed to me on June 15, 1920, says "Sardine-opener" is, perhaps, an unfortunate simile to use for the spine on the vertex of the pupa, since sardine-openers have at various times had various forms. In *milhauseri* the effective instrument is an upright spine that rather tears the softened silk than cuts it; the lid is just large enough for the moth to escape through.—A. E. W.

applies to its line of action a softening fluid, and it is the softened gum that it actually cuts or divides.

The fluid no doubt comes from the same mouth glands as in other cocoon-softening species, but the precise means by which it is guided by the spine I have not ascertained; whether the pit at its base has anything to do with it I cannot say, or whether this is a means of giving this portion of the pupa-case, which includes the eye-covers, a firm attachment to the moth; but very often it remains attached to the moth after the rest of the pupa-case has been pushed away backwards.

The imago is very delicate and easily rubbed, and such a specimen is a very disappointing representative of so curious a life-history; but a specimen in fine condition, from its delicate tints and unusual markings is very pleasing.

Imago.—Leech[16] remarks of Japanese and Chinese specimens of *milhauseri*:

> In all these specimens [three] the ground colour, especially of the secondaries, is darker than in the typical form and they are doubtless referable to var. umbrosa Staud.

I possess a male specimen from Japan, taken at Yoshino, Yamato Province, on June 21, 1901, which shows a light ground color, both in the fore and hind wings, thus approaching the typical form of *milhauseri* Fabricius. It compares well with some European examples in the British Museum (Natural History) series. Grünberg remarks that—

> In the East-Asiatic form, umbrosa Stgr. (45a), the whole outer half of the forewing is strongly darkened to the costal margin. Japanese specimens also are darker than European ones.[17] Egg pale brownish, with violet ring below pole.

Staudinger[18] described his variety *umbrosa* from a single male specimen from Askold Island, eastern Siberia and Grünberg calls this dark variety "the East Asiatic form." It is abundantly evident from Nagano's observations that in Gifu, Mino Province, Japan, the typical form of *milhauseri* Fabricius is much commoner than the variety *umbrosa* which is scarce. Therefore, as far as Japan is concerned it would seem that *umbrosa* can scarcely be called "the East-Asiatic form," but that it should merely be called a variety of the typical form of *milhauseri* Fabricius.

[16] Trans. Ent. Soc. London (1898) 309.

[17] Not always. I have a specimen fairly typical and vide Nagano's remarks, antea, page 82. Apparently, the European form is predominant at Gifu and variety *umbrosa* very scarce.—A. E. W.

[18] Rom. Mém. Lép. 6 (1892) 343.

There are three females of the form *unbrosa* Staudinger from Japan in the British Museum collection (Natural History) but no typical specimens. These are the specimens alluded to by Leech above, ex collection Pryer. They have dark hind wings, in fact very much darker than five males from Yoshino, Yamato Province, in my collection. There is also one female specimen in the British Museum collection from Berlin, Europe, the fore-wings of which are far darker than in any Japanese specimen.

Local distribution.—Honshu, Sagami Province, Oyama (*Pryer*): Musashi Province, Tokyo, June bred (*Wileman*); Yokohama (*Manley*): Yamato Province, Yoshino, June, August (*Wileman*): Mino Province, Gifu, June, August (*Nagano*). Matsumura records the variety *umbrosa* Staudinger from Hokkaido and Honshu. The female specimen bred by me at Tokyo, in June, is a typical *umbrosa.*

Time of appearance.—Larva, September and October; imago, June, July?, August. Double-brooded. Matsumura states that *Hoplitis* (*Cerura*) *milhauseri* Fab. var. *umbrosa* Stgr. is double-brooded. The first brood appears in June and the second brood in August.

General distribution.—*Hoplitis* [=*Cerura*] *milhauseri.* Distributed in central and southern Europe, but everywhere rare, not found in England; Spain, Dalmatia, countries around the Black Sea; also in northern Africa (*Grünberg*).

Form *umbrosa* Staudinger; eastern Siberia, Amurland; western China; Japan (*Grünberg*). Manchuria (*Matsumura*).

Genus **LOPHOCOSMA** Staudinger

Lophocosma STAUDINGER, Rom. Mém. Lép. **3** (1887) 222.

Lophocosma atriplaga Staudinger.

Plate 1, fig. 5, larva; fig. 6, food plant; fig. 7, head.

Japanese name, *kurosuji-shachihoko.*

Notodonta (*Lophocosma*) *atriplaga* STAUDINGER, Rom. Mém. Lép. **3** (1887) 220, pl. 12, fig. 8, ♂; LEECH, Proc. Zool. Soc. London (1888) 641, No. 287; GRAESER, Berl. ent. Zeit. (1888) 139 (larva); KIRBY, Cat. Lep. Het. (1892) 606; STAUDINGER, Rom. Mém. Lép. **6** (1892) 347; LEECH, Trans. Ent. Soc. London (1898) 311, No. 138; STAUDINGER and REBEL, Cat. Lep. Pal. **1** (1901) 107, No. 797; MATSUMURA, Cat. Insect. Jap. **1** (1905) 35, No. 284; GRÜNBERG, Seitz's Macrolep. Faun. Pal. **2** (1912) 294, pl. 46*c*, ♀?; MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo **6** (1920) No. 4, 299, No. 30, pl. 22, fig. 12, imago; pl. 27, fig. 9; pl. 28, fig. 11; pl. 33, fig. 3; text-fig. 9; MATSUMURA, Thousand Insects of Japan [Shin Nihon Senchu Dzukai (Jap.)] (1921) Additamenta 4, 774, No. 806, pl. 57, fig. 1, ♂.

The larva figured (Plate 1, fig. 5) was taken in August, 1902 (figured, September 27), at Hakodate, Oshima Province, Hokkaido (Yezo), on a tree of which the name was not noted by me. A female imago was bred from this larva on June 21, 1903, and three male imagoes were also bred on June 12 and 18, 1903, from larvæ taken at the same time and place and on the same tree. Graeser [19] gives the following notes on *Notodonta atriplaga* Staudinger:

> At Chab. [Chabarofka] I found the larva several times on *Corylus mandschurica* Maxim. At Wlad. [Wladiwostock] the larva was also not rare but was found here on *Ostrya*. I also received this species from Blag. [Blagoweschtschensk].[20]
>
> The full grown green larva looks just like a small larva of *Sphinx ligustri;* it has like the latter white and red-violet oblique stripes on the sides, two black, longitudinal streaks on the head and on the eleventh segment a somewhat bent, yellow and black hornlike protuberance ("zapfen"). It is full grown at the end of July and commencement of August; the pupa hibernates; moth in June.

I describe the larva from my artist's original figure as follows:

Larva.—Length, about 45 millimeters. Head whitish green, lined with black; mandibles black; body green, naked; darker green mediodorsal and subdorsal longitudinal stripes; spiracles black; a red spot on segments 5 and 6 just below each segmental spiracle; a faint, interrupted, yellowish spiracular line; four short, reddish, oblique stripes edged with yellow and directed toward the head obliquely upward and backward, these stripes commence on a line with the spiracles and reach halfway down the prolegs on segments 7 to 10; a longer, reddish stripe extending obliquely from the spiracle on segment 11 to end of anal claspers; anal flap edged with black; legs ochraceous; prolegs green, tipped with reddish; short caudal horn on segment 12, reddish at base and tipped with black.

Pupa.—Black, shining, smooth, inclosed in a flimsy cocoon spun in leaves of the food plant.

Local distribution.—Honshu, Sagami Province, Miyanoshita, June (*Wileman*): Shimotsuke Province, Nikko, August (*Wileman*): Musashi Province, Tokyo (*Marumo*). Hokkaido, Oshima Province, Hakodate, June (*Wileman*). Matsumura records this species from Hokkaido and Honshu.

Time of appearance.—Larva, August; imago, June and August.

[19] Berl. ent. Zeit. (1888) 139.

[20] These three places are in Amurland, eastern Siberia.—A. E. W.

General distribution.—Eastern Siberia, Amurland, southern Ussuri; Japan, often not rare (*Grünberg*); Korea (*Marumo*); Manchuria (*Matsumura*).

Genus BRACHIONYCOIDES Marumo

Brachionycoides MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 361.

Brachionycoides atrovittatum Bremer.

Plate 1, fig. 8, larva; fig. 9, food plant.

Japanese name, *kubiwa-shachihoko.*

Asteroscopus atrovittatus BREMER, Bull. Acad. Pétersb. 2 (1861) 483; Lep. Ost-Sib. (1864) 46, pl. 5, fig. 4; KIRBY, Cat. Lep. Het. (1892) 562; LEECH, Trans. Ent. Soc. London (1898) 304, No. 116; STAUDINGER, Cat. Lep. Pal. 1 (1901) 109, No. 813; MATSUMURA, Cat. Insect. Jap. 1 (1905) 36, No. 295; Thousand Insects of Japan [Zoku Nihon Senchū Dzukai (Jap.)] (1909), Suppl. 1, 77, No. 130, pl. 11, fig. 13, ♀; WILEMAN, Trans. Ent. Soc. London (1911) 284, No. 195; GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 299, pl. 45*f*, ♂?

Destolmia insignis BUTLER, Trans. Ent. Soc. London (1881) 19; LEECH, Trans. Ent. Soc. London (1898) 310, No. 131.

Notodonta toddii HOLLAND, Trans. Am. Ent. Soc. 21 (1889) 73; LEECH, Trans. Ent. Soc. London (1898) 311.

Brachionycoides atrovittatum MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 317, No. 57, pl. 22, fig. 9, imago; pl. 25, fig. 3; pl. 27, fig. 13; pl. 29, fig. 6; pl. 33, fig. 1; text-fig. 21.

The larva figured (Plate 1, fig. 8) was taken at Hakodate, Hokkaido, in September, 1902 (figured, September 22), on a species of maple, Japanese name, *itaya-kaede* (*Acer pictum* Thunberg var. *mono* Maximowicz). This larva died and consequently no imago developed, but a female of *Brachionycoides atrovittatum* Bremer was bred from a similar larva taken on July 6, 1903, at Hakodate.

Pupa.—Smooth, shining black.

I describe the larva from my artist's original figure as follows:

Larva.—Length, about 50 millimeters. Head green; dorsum whitish; tending to green in the spiracular region; a waved, yellow, subspiracular line, which is prominently edged with black on segments 2 to 11; legs dark ochraceous; prolegs green, shaded with black extending from the edging of the subspiracular, yellow stripe; anal claspers black; segmental sutures well defined and more or less tinged with yellow.

Local distribution.—Honshu, Musashi Province, Yokohama and Tokyo (*Holland, Pryer, Matsumura*), June and August (*Wileman*): Yamato Province, Yoshino, June, August (*Wile-*

man): Kii Province, Nachi (*Marumo*): Shimotsuke Province, Nikko, July (*Wileman*): Sagami Province, Miyanoshita, June (*Wileman*). Hokkaido (Yezo), Oshima Province, Tobetsu and Junsai Numa, July and August (*Wileman*). Matsumura records this species from Honshu and Hokkaido.

Time of appearance.—Larva, September; imago, June to August.

General distribution.—Japan; eastern Siberia, Ussuri (*Grünberg*); Manchuria (*Matsumura*).

The type of *Asteroscopus* (*Brachionycoides*) *atrovittatus*, sex?, was taken by Maack in the Lower Ussuri, eastern Siberia, in June. The type of *Destolmia insignis*, female, was taken at Tokyo by Fenton. The type of *Notodonta toddii*, a female, was taken at Yokohama.

In the British Museum (Natural History) this species is placed under Genus *Microphalera* Butler, but Marumo has founded a new genus for its reception in his revision of the Notodontidæ of Japan, Corea, and Formosa.

Genus **DRYMONIA** Hübner

Drymonia HÜBNER, Verz. Schmett. 144 (1822).

Drymonia lineata Oberthür.

Plate 2, fig. 1, larva; fig. 2, food plant.

Japanese name, *shima-shachihoko*.

Notodonta lineata OBERTHÜR, Étud. d'Ent. 5 (1880) 61, pl. 2, fig. 7, ♂; LEECH, Proc. Zool. Soc. London (1888) 639, No. 277; STAUDINGER, Rom. Mém. Lép. 6 (1892) 356; LEECH, Trans. Ent. Soc. London (1898) 310, No. 132; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 108, No. 803; MATSUMURA, Cat. Insect. Jap. 1 (1905) 35, No. 287; GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 296, pl. 45*d*, ♂.

Pheosia octofasciata MATSUMURA, Thousand Insects of Japan [Zoku Nihon Senchū Dzukai (Jap.)] (1909) Suppl. 1, 54, pl. 9, fig. 9, imago, ♂.

Drymonia lineata MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 337, No. 91, pl. 22, fig. 21, imago.

The larva figured (Plate 2, fig. 1) was taken in July, 1902 (figured, July 19), at Hakodate, Oshima Province, Hokkaido, on *sennoki* (*Acanthopanax ricinifolium* Siebold and Zuccarini), also known as *hari-giri*. It pupated on July 25, 1902, and a male imago emerged on August 7, 1902. I describe the larva from my artist's original figure as follows:

Larva.—Length, about 41 millimeters. Head grayish white faced with green; body bluish green; broad, mediodorsal and sub-

dorsal, yellow stripes; two minute, black spots on each segment of dorsum on the edge of the subdorsal, yellow stripes; laterally paler; ventrum whitish; legs, prolegs, and claspers greenish white.

Local distribution.—Honshu, Shinano Province (*Marumo*). Hokkaido, Oshima Province, Tobetsu (June, July, August), Hakodate (August), Junsai Numa (August) (*Wileman*): Ishikari Province, Jozankei, June to August (*Wileman*), Sapporo (*Marumo*). Matsumura records the species from Hokkaido.

Time of appearance.—Larva, July; imago, May to August.

General distribution.—Eastern Siberia, southern Ussuri, Japan (*Grünberg*).

In the British Museum (Natural History) this species is placed under *Notodonta* but Marumo, in his revision of the Notodontidæ of Japan, Corea, and Formosa, transfers it to *Drymonia* Hübner.

Oberthür's type was, apparently, one of two males taken in May and June, 1878, on Askold Island, eastern Siberia.

Genus **HYPERÆSCHRA** Butler

Hyperæschra BUTLER, Ann. & Mag. Nat. Hist. V **6** (1880) 65.

Hyperæschra biloba Oberthür.

Plate 1, fig. 10, larva; fig. 11, head; fig. 12, food plant.

Japanese name, *kunugi-shachihoko.*

Drymonia biloba OBERTHÜR, Étud. d'Ent. **5** (1880) 63, pl. 8, fig. 1, ♂; STAUDINGER, Rom. Mém. Lép. **6** (1892) 358; STAUDINGER and REBEL, Cat. Lep. Pal. **1** (1901) 109, No. 287; WILEMAN, Trans. Ent. Soc. London (1911) 295, No. 216; GRÜNBERG, Seitz's Macrolep. Faun. Pal. **2** (1912) 302, pl. 45*d*, ♂.

Hyperæschra biloba MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo **6** (1920) No. 4, 318, No. 58, pl. 22, fig. 23, imago, ♀; pl. 29, fig. 5; pl. 36, fig. 6.

Hyperæschra basalis Matsumura (? nec Moore) Thousand Insects of Japan [Shin Nihon Senchū Dzukai (Jap.)] Additamenta **4** (1921) 798, No. 831, pl. 58, fig. 8, ♂, ? nec Moore.

The larva figured (Plate 1, fig. 10), was taken in August, 1902 (figured, August 22), at Hakodate, Oshima Province, Hokkaido, on *hannoki* (*Alnus japonica* Siebold and Zuccarini), also known as *harinoki* and *yachihannoki.* No imago was bred from this larva as it died, but a male imago was bred on June 22, 1903, from a similar larva taken during 1902. I describe the larva from my artist's original figure as follows:

Larva.—Length, 49 millimeters. Head green lined with black; body green; a mediodorsal, pink stripe broadly edged on

both sides with white; spiracles white, ringed with black; seven lateral, pink stripes, broadly edged with white, directed obliquely toward the head upward and backward, from segments 5 to 12; similar small dashes on segments 3 and 4 directed obliquely anad, upward and backward; legs ochraceous, prolegs, claspers, and ventrum green.

Pupa.—Black, smooth and glossy; inclosed in a frail cocoon spun among leaves of the food plant.

Local distribution.—Honshu, Yamato Province, Yoshino, July, August (*Wileman*) : Shimotsuke Province, Nikko, August (*Wileman*) ; Kii Province and Kaga Province (*Marumo*) ; Yamashiro Province, Kyoto, June (*Matsumura*). Hokkaido, Oshima Province, Hakodate and Junsai Numa, June, July (*Wileman*) ; Ishikari Province, Tobetsu, July (*Wileman*).

Time of appearance.—Larva, August; imago, June to August.

General distribution.—Eastern Siberia, southern Ussuri; Japan (*Grünberg*). Type of *Drymonia biloba,* male, from Askold Island, eastern Siberia.

In the British Museum (Natural History) this species is placed under the genus *Hyperæschra* Butler and also by Marumo in his revision of the Notodontidæ of Japan, Corea, and Formosa.

The following notes on three very closely allied species of the genus *Hyperæschra* may be of value for determining their respective merits as distinct and valid Japanese species.

Hyperæschra basalis Moore.

Notodonta basalis MOORE, Proc. Zool. Soc. London (1865) 813.

Hyperæschra basalis HAMPSON, Moths India 1 (1892) 165, text-fig. 101, ♂; MATSUMURA, Thousand Insects of Japan [Shin Nihon Senchū Dzukai (Jap.)] Additamenta 4 (1921) 798, No. 381, pl. 58, fig. 8, ♂ (*kunugi-shachihoko*) (? nec Moore=*? biloba* Oberth.).

There are five males of this species in the British Museum (Natural History) from Sikkim and Darjiling, India. The species differs in color, expanse, bipectination of antennæ, and the angulation of postmedial line of forewing from *Hyperæschra biloba* Oberthür with which it has been associated by Matsumura. The antennæ of *basalis* Moore male are bipectinate for the proximal three-fourths length of the shaft while in *biloba* Oberthür they are bipectinate almost to the apex of the shaft. *Hyperæschra basalis* Moore has the basal half of forewings very much darker in color (inside the postmedial line); the expanse is about 50 millimeters against a maximum of 46

millimeters for *biloba* Oberthür. Matsumura, in his last work, under "*Hyperæschra basalis* Moor [e] (=*biloba* Oberthür) Japanese name kunugi-shachihoko," sinks *biloba* Oberthür in *basalis* Moore, of which he gives a figure. This figure seems to compare fairly well with Hampson's figure of *basalis* Moore, from which it may perhaps have been copied, and also with specimens of that species in the British Museum collection, but it may possibly have been taken from a Japanese specimen in the possession of Matsumura. If so, and if the antennæ are bipectinate for the proximal three-fourths of the shaft, then *basalis* Moore should be recognized as a distant Japanese species.

Hyperæschra basalis Moore and *biloba* Oberthür are, therefore, two quite distinct species as an examination of the series of the former in the British Museum (Natural History) proves and are separated in that collection. I have alluded to the resemblance of the two species.[21]

Hyperæschra tusa Swinhoe.

Hyperæschra tusa SWINHOE Ann. & Mag. Nat. Hist. VII 19 (1907) 207.

Of this species there is one specimen only in the British Museum (Natural History), the male type from Japan, and this species is placed between *Hyperæschra basalis* Moore and *H. biloba* Oberthür. It will, however, I think, be eventually proved to be merely a large, darker form of *H. biloba* Oberthür but, owing to the lack of sufficient material, must, for the present, be left as a distinct species. It expands 51 millimeters; the color is rather darker than that of *biloba* as figured by Oberthür; antennæ the same as in *biloba*, but the angulation of the postmedial line is rather different as at vein 1 it is more excurved and from veins 1 to 4 more incurved. As this species has not hitherto appeared in any catalogue of Japanese Heterocera I append Swinhoe's original description herewith.

♂. Dark grey: forewings with more than the basal half much darker than the outer portions, limited by a thick black line from the costa at two-thirds to vein 4, then curved inwards to vein 1, then obliquely inwards to the production at the middle of the hinder margin, where it is very thick; a black mark just inside this on the margin, and two black angles between them, forming the commencement of a transverse line; an indistinct, grey, transverse, sinuous band in the disc: hind wings grey, without markings;

[21] Trans. Ent. Soc. London (1911) 295.

cilia of fore wings ochreous grey, of hind wings pale grey, both with darker patches: antennæ, body, legs and wings on the underside pale grey, uniform in colour, a slightly darker medial band across both wings. Expanse of wings 2 inches.

Japan (*Schaus*) (type in B. M.).

Allied to *H. basalis*, Moore.

Hyperæschra biloba Oberthür.[22]

One male specimen in British Museum (Natural History) from Miyanoshita, Sagami Province; Honshu, August 27, 1910, expanse 42 millimeters. In my collection I have eight males measuring 42 to 47 millimeters as follows: One male which represents the male imago bred on June 22, 1903,[23] and measures 44 millimeters agrees well in color, markings and angulation of the postmedial line with Oberthür's figure of *Drymonia biloba*,[24] which, he states in the text, was bred June 29, 1879, on Askold Island, eastern Siberia. In this specimen the postmedial line of forewing is just slightly more deeply incurved between veins 1 and 4 than in Oberthür's figure. Three males from Hokkaido, Oshima Province, Junsai Numa, July 25 and 29, 1902, (plains) and Ishikari Province, Tobetsu, July 7, 1902, (plains); three males from Honshu, Yamato Province, Yoshino (about ? 800 feet), expanse 42 millimeters, July 14, 1899, and August 15, 1894. Two of the latter specimens are rather smaller in expanse than the others and agree better in coloration with *tusa* Swinhoe than with Oberthür's figure but not in the angulation of the postmedial line. One male from Shimotsuke Province, Nikko, August 16, 1893. As previously remarked I think that *tusa* Swinhoe and *biloba* Oberthür will probably be found to be identical species with a modified angulation of the postmedial line of forewing in different individuals. Marumo [25] states that—

> the angulation is modified among the sexes. In the male the postmedial line more deeply incurved between veins 1 and 4 than in the female, and the angulation at vein 1 acute, the space between the ante- and postmedial lines being broader.

Further material, breeding, and examination of genitalia are necessary before it can be satisfactorily decided whether *tusa* Swinhoe is the same species as *biloba* Oberthür. One of my specimens of *biloba* from Tobetsu July 7, 1902, approaches

[22] For synonymy and bibliography see antea, page 90.

[23] See antea, page 90.

[24] Oberthür, Étud. d'Ent. 5 (1880) 63, pl. 8, fig. 1, ♂.

[25] Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 318, No. 58.

tusa in expanse (47 millimeters), coloration, and angulation of postmedial line. As *Hyperæschra basalis* Moore is apparently not a Japanese species, the Japanese name of kunugi shachihoko given to it by Matsumura should be transferred to *Hyperæschra biloba* Oberthür.

Genus **SPATALIA** Hübner

Spatalia HÜBNER, Verz. bek. (1822) 145.

Spatalia ornata Oberthür.

Plate 2, fig. 3, larva, green form; fig. 4, larva, violet-gray form; fig. 5, food plant; fig. 5*a*, imago, ♂. Larva of *Spatalia* (*Rosama*) *macrodonta* Butler.

Japanese name, ***hitogimboshi-shachihoko***.[26]

Ptilodontis ornata OBERTHÜR, Étud. d'Ent. **10** (1884) 15, pl. 2, fig. 5, ♂; STAUDINGER, Rom. Mém. Lép. **6** (1892) 362; Cat. Lep. Pal. **1** (1901) 110, No. 834; LEECH, Trans. Ent. Soc. London (1898) 315; GRÜNBERG, Seitz's Macrolep. Faun. Pal. **2** (1912) 304, pl. 46*f*, ♂ ♀.

Spatalia ornata MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo **6** (1920) No. 4, 291, No. 15, pl. 28, fig. 5; pl. 32, fig. 4.

Rosama macrodonta BUTLER, Cist. Ent. **3** (1885) 127; LEECH, Proc. Zool. Soc. London (1888) 637, No. 267; Trans. Ent. Soc. London (1898) 315, No. 150; MATSUMURA, Cat. Insect. Jap. (1905) 37, No. 304; GRÜNBERG, Seitz's Macrolep. Faun. Pal. **2** (1912) 304 (no figure).

Spatalia ornata Oberthür (part) MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo **6** (1920) No. 4, 291, No. 15.

Two forms of the larva (Plate 2, figs. 3 and 4) were taken at Yoshino, Yamato Province, Honshu, on *hagi* (*Lespedeza bicolor* Turczaninow). Form 1 (Plate 2, fig. 3), light green form, was taken in October, 1900 (figured, October 15). Form 2 (Plate 2, fig. 4), violet-gray form, was taken in November, 1900 (figured, November 2).

A male imago emerged on May 28, 1901, and another male imago, on June 9, 1901.

The imago of *Spatalia macrodonta* Butler apparently has never been figured by any author. I have figured it on Plate 2, fig. 5*a*, from a male specimen in my collection. I describe forms 1 and 2 from my artist's original figures as follows:

Form 1.—Length, about 27 millimeters. The larva is somewhat shrunken as it was preparing to pupate. Light green with a darker, mediodorsal line and a few short hairs; a yel-

[26] No Japanese name has been given to this species by Matsumura; therefore, I name it as above.

lowish, spiracular line; spiracles black; legs grayish; prolegs green tipped with gray; on segment 12 a slight prominence which bears two, grayish, hairy, dorsal tubercles.

Form 2.—Length, 36 millimeters. Ground color pale violet-gray; head gray; a well-defined, mediodorsal, violet-gray stripe from segment 2 (counting head as segment 1); a mediolateral, violet-gray stripe, shaded beneath with light yellow, running from segment 2 to segment 12; a violet-gray, spiracular stripe, shaded below with broader yellow running from segment 2 to anus; spiracles black; ventrum, all legs, and anal segment violet-gray.

Pupa.—The pupa is inclosed in a frail cocoon, which was spun in a leaf of the food plant.

Imago.—I have a series of nine males and four females from Japan. In the males there is a silver marking situated at the base of vein 2. In one male this mark is practically obsolete; in three males it takes the form either of a small spot or a slender streak; in five males this spot, or streak, becomes enlarged to the shape of a triangular wedge and these specimens agree with the figure of *Ptilodontis ornata* Oberthür, in which it is large and a little larger than in my five male specimens.

In two females the silver mark is obsolete; in two others it is just faintly discernible as a slender streak. In the collection of the British Museum (Natural History) there are two males from Japan, including the type, and three females, one from Japan and two from Pekin, North China (female types).

The type male and the second male have a slender streak at vein 2.

The females have apparently no streak, but they are rather rubbed and it is therefore difficult to be quite certain about this.

Butler does not mention this silver marking in his descriptions of the type male and female, one from Japan, the other from China.

Marumo says:[27]

> The silvery spot at the base of vein 2 of the forewing is much reduced in size or entirely absent in the female.
>
> Although I have not examined the types of both *ornata* and *macrodonta* I can not find any specific distinction between them according to their original description.

[27] Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 291, No. 15, pl. 28, fig. 5; pl. 32, fig. 4.

He therefore regards *Spatalia* (*Rosama*) *macrodonta* Butler as a probable synonym of *Spatalia* (*Ptilodontis*) *ornata* Oberthür. I strongly agree with this opinion. *Ornata* Oberthür is not represented in the collection of the British Museum (Natural History) either as a synonym of *macrodonta* Butler or as a separate species. This perhaps is not surprising as the family of the Ceruridæ (Notodontidæ) in the British Museum collection has been awaiting revision for some years. Grünberg,[28] although he quotes *Spatalia macrodonta* Butler in his text, gives no figure of it, but gives male and female figures of *Spatalia ornata* Oberthür. The male of *ornata* figured by Seitz, which has perhaps been copied from Oberthür's figure or type, differs chiefly from typical *macrodonta* in the triangular shape and much larger size of the silver marking. The female of *ornata,* however, figured by Seitz agrees remarkably well with a fresh, unrubbed, female specimen of *macrodonta* Butler in my collection. I consider that *macrodonta* Butler should be sunk in *ornata* Oberthür which has priority. The silver spot at base of vein 2 is in *macrodonta* evidently subject to much variation. Oberthür described and figured his species from one of four male specimens taken at Sidemi, Ussuri, eastern Siberia. The female of *ornata* Oberthür, as figured in Seitz, has no silver spot and in this respect agrees with the females of *macrodonta* in the British Museum collection and with two of my females.

Local distribution of Spatalia macrodonta Butler.—Honshu, Yamato Province, Yoshino, June, September, bred in June (*Wileman*): Shimotsuke Province, Nikko, July (*Wileman*). Kyushu, Hyuga Province, Shimo-shiiba, July (*Wileman.*) Matsumura records this species from Honshu only.

Marumo gives the local distribution of *Spatalia ornata* Oberthür as follows: Honshu, Shimosa Province; Kaga Province; Musashi Province, Tokyo and Yokohama. Shikoku Island, no localities given. Therefore, the species *Spatalia ornata* (including *macrodonta*) is found in the three islands of Honshu, Shikoku, and Kyushu.

Time of appearance.—Larva, October, November; imago, June and July (*Wileman*); August (*Marumo*).

General distribution.—Japan; northern China (Grünberg).

[28] Seitz's Macrolep. Faun. Pal. 2 (1912) 304.

Genus **LOPHOPTERYX** Stephens

Lophopteryx STEPHENS, Ill. Brit. Ent. Haust. 2 (1829) 26.

Lophopteryx saturata Walker.

Plate 2, fig. 6, larva; fig. 7, food plant; fig. 8, anal section, dorsal aspect. Japanese name, *momiji-shachihoko*.[29]

Lophopteryx saturata WALKER, Cat. Lep. Het. 32 (1865) 415; OBERTHÜR, Étud. d'Ent. 5 (1880) 66; BUTLER, Ill. Typ. Lep. Het. 6 (1886) 25, pl. 107, fig. 1; HAMPSON, Moths Brit. India 1 (1892) 166, fig. 102, ♂; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 110, No. 842; GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 307, pl. 46*h;* WILEMAN, Trans. Ent. Soc. London (1911) 295; MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 301, No. 33.

Lophopteryx hoegei GRAESER, Berl. ent. Zeit. (1888) 143 (larva); STAUDINGER, Rom. Mém. Lép. 6 (1892) 360; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 110, No. 842*a;* GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 308 (no figure); MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 301; No. 33, pl. 23, fig. 22, ♂.

The larva figured (Plate 2, fig. 6), was taken in October, 1902 (figured, October 7), at Hakodate, Oshima Province, Hokkaido, on a species of maple, Japanese name, *itaya-kaede,* also known as *o-tsutamomiji* (*Acer pictum* Thunberg). The larva died and no imago was bred from it, but I bred three female imagoes of *Lophopteryx saturata* Walker from similar larvæ at Hakodate on September 2, 1902, and July 7, 1903.

In the British Museum (Natural History) collection there are fifteen male specimens of *Lophopteryx saturata* Walker but no females, all with one exception from India (Darjiling, Bengal Province, about ? 7,000 feet) and Sikhim (Pilcher, May, 1896, 7,000 feet; F. Möller, August and September, 1909). The one exception is from Japan, unlocalized (B. Bristowe, 1901). This specimen seems to be nearer typical *hoegei* Graeser than *saturata* Walker. In my collection I have four males and seven females of *saturata* Walker and variety *hoegei* Graeser taken, as noted in the local distribution on page 100, in June to September. The three females[30] bred at Hakodate on September 2, 1902, and July 7, 1903 are, I think, referable to *saturata* Walker, not to variety *hoegei* Graeser. The type of *Lophopteryx saturata* Walker comes from Darjiling (about

[29] No Japanese name has been given to this species by Matsumura: therefore, I name it as above.

[30] Vide preceding paragraph.

? 7,000 feet) and was originally in the Atkinson collection but is now, I believe, in the Berlin Museum.

Grünberg[31] comments on *Lophopteryx saturata* Walker as follows:

L. saturata *Walk.* (46h). A North Indian species closely related to *camelina,* and lately also found in Japan. Forewing dark red brown with a grey tone and sharp black pre- and postdiscal bands. Hindwing greyish brown, the black anal spot bounded by a sharp whitish transverse line.

In the southern Ussuri-district the species is represented by a special form, hoegei *Graes.*, which differs from the closely allied *camelina* and *giraffina* in the colouring being darker, more brown-grey, and in the black markings being more sharply developed; moreover, the outer edge of the median band is less sharply dentate, more straight, the lobe of scales at the hind margin paler than the ground.

Graeser[32] says of *Lophopteryx hoegei* Graeser:

I reared seven ♂♂ and three ♀♀ of this new species at Wlad. [Wladiwostock]. It comes near to *Camelina,* and reminds one on superficial observation of dark specimens of ab. *Giraffina* Hb. Herr Cristoph, to whom I sent one of my specimens, also identified it as an exceptionally sharply defined and aberrant specimen of *Giraffina,* which however is, at once contradicted by the quite different larva which is described further on.

Hoegei has the expanse of a middle-sized *Camelina;* male expanse 32–34 m. m.; female expanse 36–39 m. m. The fore wings are not so much excurved at the anterior angle as in *Camelina,* but the costal margin is here somewhat shortened, the hind margins of the wings are less sharply dentate at the nervures, the hind wing, in particular, is not conspicuously dentate at the anal angle, but runs here almost straight, scarcely perceptibly excurved. The whole insect is darker and more brownish-grey than *Camelina* and *Giraffina.* The ground colour of the fore wings is a dark brownish-grey, that of the hind wings a dull smoky-grey ["trüb rauchgrau"]; *Hoegei* never has rust-brown fore- and brownish-yellow hind wings like *Camelina* in which also the hind wings are always much lighter coloured than the fore wings. All markings agree in their arrangement tolerably well with those of *Camelina,* they are however more delicate and in all ten specimens are more sharply defined than in the former, which sometimes appears quite devoid of markings. In the fore wing of *Hoegei* the outer edge of the median band is very sharply defined; it consists of a slender black line and of a broader greyish-yellow line lying parallel with it and runs much straighter, not so sharply dentate as in *Camelina,* moreover the two pointed spurs directed inwards between veins 4 to 6 are also missing, it runs here in a gentle arch which is scarcely dentate. The fringes of the outer margin are somewhat lighter from the hinder angle to vein 4, from there to the anterior angle just as dark as the wing. The lobe of scales of the inner margin is in *Hoegei* somewhat paler than the ground colour, whereas in *Camelina* it is constantly of a darker shade. On the outer margin of the hind wings there

[31] Seitz's Macrolep. Faun. Pal. 2 (1912) 307.
[32] Berl. ent. Zeit. (1888) 144, No. 376.

is a thin pale terminal line before the darker fringes; between the anal angle and vein 2 there is a small mark; this consists of a pale yellow transverse streak, bordered on each side by black; bordering this there is a patch of blue-grey scales. The underside of all wings is an uniform smoky-grey, the anterior margin is quite narrowly suffused with yellow near the anterior angle, the fringes of all wings somewhat darker than these even.

The thorax is crested and hairy, also the patagia, and it is coloured grey brown tinged with lighter; the body smoky grey on both sides; antennæ dark brown, the same as in *Camelina;* the palpi, which project but little, dark brown as well as the whole head, between the antennæ blackish; pectus and legs very hairy, dark brown; feet ringed with paler colour; hind tibiæ have two pairs of spurs.

My artist's original figure of the larva figured (Plate 2, fig. 6) of *Lophopteryx saturata* Walker agrees well with Graeser's description of the larva of *Lophopteryx hoegei* Graeser which I have translated as follows:

Full grown larva, length 50 millimeters; very slender, pale yellow, the glossy black head is globular, the first segment behind that swollen like a blister, the upper half reddish-yellow; from the second to the eleventh segment run seven thick black longitudinal lines, one of which is mediodorsal and another just over the black spiracles; segment 11 with a prominence which bears two obtuse brick-red tubercles situated close together which are joined by the black longitudinal lines; the dorsal area behind these tubercles is sprinkled with irregular black spots and points; an oval black spot on the anal flap. Laterally a broad sulphur yellow longitudinal stripe from head to anus; the body black below this stripe; a narrow pale yellow stripe on the ventrum which is somewhat widened at each pair of feet. Thoracic legs yellow with black claws, abdominal legs black with slender yellow rings. The whole larva shines like lacquer, naked with quite isolated, fine hairs.

In two broods, gregarious on maple in August. A brood of 30 full grown larvæ were found on a maple tree on 2 August, which pupated a few days later, the imagoes emerging on 22 August. Some of these were allowed to breed, the larvæ emerged from the blue-green ova on 4 September and pupated at the commencement of October; about 130 pupæ which were obtained from these went to earth during the journey.

I may mention here that the larva of the very closely allied species *Lophopteryx camelina* Linnæus which is recorded from Japan, is so different in color that it seems worth while quoting Wilson's [33] description of that larva as follows:

Larva [of *Notodonta camelina* Linnæus]. Bright green, much lighter on the dorsal area, with some scattered white warts; dorsal line blue-green, passing between two red humps on the 12th segment, these red humps have each a tuft of black hairs; spiracular line yellow; spiracles black, encircled with white; and beside each is a pink blotch; segmental divisions yellow;

[33] Larvæ of British Lepidoptera (1880) 195, pl. 30, figs. 1, 1*a*.

there are a few black dots and some black hairs on the body; ventral area green; head yellow-green and shining, yellower towards the mouth; legs and claspers pink. In some varieties the ground color is yellowish buff. The larva rests with the 13th segment raised, and its head curved back over the body. *Plate XXX, figs. 1, 1a.*

Eggs laid on the 16th of July, hatched on the 24th of the same month. When first hatched, the larva is whitish, the head black, large, and shining.

Food plants. Apple, Alder, Birch, Beech, Elm, Hazel, Lime, Maple, Oak, Sallow, Whitethorn, Willow.

Pupa. In a slight cocoon under moss on trees.

Time of appearance.—*Larva.* July to October. Pupa. *October to May. Imago.* May to September.

Localities. Great Britain and Ireland; common.

Imago.—Staudinger [34] remarks:

Graeser described his *Hoegei* from 10 specimens reared at Wlad. [Wladiwostock], the larvæ of which lived on oak [35] and which were very different from those of *Camelina.*

According to his description in which however the transverse lines do not agree, being quite different, *hoegei* is the same species as specimens from Ask. [Askold], which Oberthür quotes,[36] as *saturata* Moore from an Askold male, and of which I have two males from Askold from Dörries. *Lophopteryx saturata* from Sikkim was not described by Moore, but by Walker, and 4 males from Darjiling, which lie before me, agree so well with my two Askold specimens that the latter can, in any case, only be a very slightly varying local form of it. Moreover *saturata* are somewhat browner, darker brown on the fore wings, and the hind wings also are a dark brownish gray, not "trüb rauchgrau" [dull smoky grey], as Graeser calls it. They are also lighter on the underside than those of *saturata.*

Local distribution.—Honshu, Shinano Province, Karuizawa, July (near typical *Lophopteryx saturata* male) (*Wileman*). Hokkaido, Oshima Province, Tobetsu, Junsai Numa, and Hakodate, June, July, August, September (bred August, September) (*Wileman*): Ishikari Province, Sapporo, August (*Wileman*). Matsumura does not record *Lophopteryx saturata* from Japan but records the very closely allied species *Lophopteryx camelina* Linnæus from Hokkaido and Honshu.

[34] Rom. Mém. Lép. 6 (1892) 360.

[35] Graeser says "Ahorn gebüsch" [Maple], not "Eiche" [Oak] as Staudinger states, and my larvæ were also found on maple. I have given this species the Japanese name of *momiji-shachihoko* for this reason.

[36] Etudes 5: 66.

Time of appearance.—Larva, July, August, October; imago, June to September. A pupa bred from an October larva hibernated and emerged in June of the following year, so that the hibernating pupæ apparently produce the imagoes which appear in June and there may be two broods in the year.

General distribution.—*Lophopteryx saturata* Moore, India (Sikkim), Japan (*Wileman*). *Lophopteryx hoegei* Graeser, East Siberia (Ussuri); Japan (*Wileman*).

Genus **EUHAMPSONIA** Dyar

Euhampsonia DYAR, Trans. Am. Ent. Soc. **24** (1897) 14.

Euhampsonia cristata Butler.

Plate 2, fig. 9, larva; fig. 10, food plant; fig. 11, head.

Japanese name, *sedaka-shachihoko.*

Trabala cristata BUTLER, Ann. & Mag. Nat. Hist. IV **20** (1877) 480; Ill. Typ. Lep. Het. 2 (1878) 18, pl. 27, fig. 1, ♀; PRYER, Trans. Asiat. Soc. Japan **12** (1883) 55, No. 217; LEECH, Proc. Zool. Soc. London (1888) 628, No. 233; GRAESER, Berl. ent. Zeit. **32** (1888) 142 (larva); KIRBY, Cat. Lep. Het. (1892) 614; STAUDINGER, Rom. Mém. Lép. **6** (1892) 367; LEECH, Trans. Ent. Soc. London (1898) 297, No. 93; STAUDINGER and REBEL, Cat. Lep. Pal. **1** (1901) 111, No. 855; MATSUMURA, Cat. Insect. Jap. **1** (1905) 38, No. 313; Thousand Insects of Japan [Zoku Nihon Senchū Dzukai (Jap.)] (1909) Suppl. 1, 45, No. 73, pl. 7, fig. 4, ♀; GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 310, pl. 47*b*, ♂, ♀; MATSUMURA Ōyō Konchūgaku (Practical Entomology) ed. 2. (1920) 712 (Jap.).

Euhampsonia cristata MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo **6** (1920) No. 4, 329, No. 78, pl. 22, fig. 3, ♂; pl. 31, fig. 6; pl. 35, fig. 1; text fig. 30.

The larva figured (Plate 2, fig. 9) was taken in September, 1902 (figured, September 21), at Hakodate, Oshima Province, Hokkaido, on dwarf oak, Japanese name, *ko-nara* (*Quercus glandulifera* Blume). This larva died without developing an imago, but I have bred imagoes on several occasions at Tokyo, Honshu, from similar larvæ taken on oak. It is quite impossible to mistake it for the larva of any other Japanese cerurid (notodont).

Graeser[37] describes the larva of *Nadata* [=*Euhampsonia*] *cristata* Butler as follows:

I found the full grown larvæ not rare in the second half of August on oak. It is naked, of a whitish green ground color and has laterally on each segment bright yellow oblique stripes; head very large, globular, whitish green; the pupa hibernates.

[37] Berl. ent. Zeit. **32** (1888) 142.

Matsumura[38] states that *Euhampsonia splendida* Oberthür—

male, is not rare at the end of July in Sapporo [Hokkaido]. I have never yet taken a female. I think that it perhaps may be the male of the Sedaka-shachihoko [*Euhampsonia cristata* Butler].

Judging by the following facts, however, it is evident that *cristata* Butler and *splendida* Oberthür are two quite distinct species with different larvæ and that the females of each are distinct and well known.

1. The male antennæ of *cristata* Butler are bipectinate for the proximal three-fourths length of the shaft and the pectinations are nearly one-third longer than in male *splendida* Oberthür. The antennæ of *splendida* Oberthür are bipectinate for the proximal five-eighths length of the shaft and the pectinations are slenderer and shorter than those of *cristata* Butler.

2. Graeser[39] states of *Nadata splendida* Oberthür:

I bred 4 ♂ and a ♀ from the larvæ. I found these full grown from 23 August to 3 September on oaks where they generally rest on the underside of a leaf which has been spun over with thin white threads. The large larva 70–80 m. m. long is of an uniform greenish white, the large globular head also is of this colour. The pupa hibernates.

In the previous number, on the same page (142), Graeser has already described the larva of *Nadata cristata* Butler and in the next number he describes the larva of *Nadata splendida* Oberthür. It is very evident therefore that he bred the larvæ of both species and he specially mentions that he bred a female of *splendida* Oberthür from the larva. Staudinger[40] also says of *Nadata* (*Euhampsonia*) *splendida* that "Christoph found (bred) a ♀ end of June, a ♂ end of July at Wlad. [Wladiwostock]," so that there seems no doubt that *Euhampsonia splendida* has a well-defined distinct female, but it seems to be, for some reason, very scarce. The larva of *E. splendida* Oberthür lacks the bright yellow oblique stripes of *cristata* Butler which however are white in my Japanese figure of *cristata*.

I describe the larva from my artist's original figure as follows:

Larva.—Length, about 52 millimeters. Head light green and mandibles tinged with pink; naked, glossy; dorsally whitish green; laterally and ventrally of a darker green; seven white

[38] Thousand Insects of Japan [Shin Nihon Senchū Dzukai (Jap.)], Additamenta 4 (1921) 815, No. 815, pl. 59, fig. 13, ♂.

[39] Berl. ent. Zeit. 32 (1888) 142.

[40] Rom. Mém. Lép. 6 (1892) 366.

lateral stripes commencing on segment 5 directed toward the anus obliquely upward and backward; legs ochraceous; prolegs and claspers green; anal flap edged with yellow. It will be noted that Graeser describes the lateral stripes as yellow, but all the larvæ of this species observed by me were marked with white stripes. I have also sometimes found it feeding on *akebi* (*Akebia quinata* Decaisne).

Pryer remarks that "the larva of this fine Notodonta closely resembles that of a Smerinthus."

Local distribution.—Honshu, Musashi Province, Yokohama (*Jonas, Pryer*) : Shinano Province, Oiwake (*Pryer*) : Omi Province, Nagahama, July (*Leech*) : Yamato Province, Yoshino, July, August (*Wileman*): Musashi Province, Tokyo, June (bred), July (*Wileman*): Sagami Province, Onuma, July (*Wileman*). Hokkaido, Oshima Province, Hakodate (larva), September (*Wileman*). Matsumura records this species from Hokkaido and Honshu.

Time of appearance.—Larva, September; imago, June to August. Hibernates in the pupal stage.

General distribution.—Eastern Siberia, southern Amurland; North China; Japan (*Grünberg*). Manchuria (*Matsumura*). Type, female, from Yokohama (*Jonas*).

Genus **ICHTHYURA** Hübner

Ichthyura HÜBNER, Verz. bek. (1822) 162.

Ichthyura anachoreta Fabricius.

Plate 1, fig. 13, larva; fig. 14, food plant.

Japanese name, *tsumaaka-shachihoko*.

Bombyx anachoreta FABRICIUS, Mant. Ins. 2 (1787) 120 (= *curtula* Esper; *fulgurita* Walker); HÜBNER, Bomb. (1880) pl. 22, fig. 88; LEECH, Proc. Zool. Soc. London (1888) 636, No. 261; STAUDINGER, Rom. Mém. Lép. 6 (1892) 373; HAMPSON, Moths Brit. India 1 (1892) 172, larva; LEECH, Trans. Ent. Soc. London (1898) 317, No. 156; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 112, No. 869; MATSUMURA, Cat. Insect. Jap. 1 (1905) 39, No. 321; Thousand Insects of Japan [Zoku Nihon Senchū Dzukai (Jap.)] (1909) Suppl. 1, 53, No. 87, pl. 9, fig. 6, ♂; NAGANO, Nawa's Insect World [Konchu Sekai (Jap.)] 13 (1909) 445, pl. 21, fig. 3, ♂; fig. 4, ♀; fig. 16, larva; fig. 18, pupa; fig. 17, cocoon; SASAKI, Nihon Jūmoku Gaichūhen (Insects Injurious to Japanese Trees) ed. 3 (1910) pt. 2, 161, text-fig. 150, larva, imago ♂; GRÜNBERG, Seitz's Macrolep. Faun. Pal. 2 (1912) 314, pl. 47g, ♂; NAGANO, Bull. Nawa Ent. Lab. 1 (1916) 9, pl. 3, figs. 11–20, pl. 9, fig. 23, larva; MARUMO, Journ. Coll. Agr. Imp. Univ. Tokyo 6 (1920) No. 4, 333, No. 84, pl. 29, fig. 12; pl. 38, fig. 6; MATSUMURA, Ōyō Konchugaku [Practical Entomology] ed. 2 (1920) 714, (Jap.).

Ichthyura fulgurita WALKER, Cat. Lep. Het. 32 (1865) 433; KIRBY, Cat. Lep. Het. (1892) 611.

Nerice pallida WALKER, Cat. Lep. Het. 5 (1855) 1087; STAUDINGER, Stett. ent. Zeit. (1887) 101; GRÜNBERG, Seitz's Macrolep Faun. Pal. 2 (1912) 315.

The larva figured (Plate 1, fig. 13) was taken in November, 1900 (figured, November 6) at Kobe, Settsu Province, Honshu, on a species of sallow, Japanese name, *yanagi*[41] and a male imago emerged from the pupa on April 20, 1901. Hampson[42] describes the larva as follows:

Larva pale brown, covered sparsely with short pale hair; a dorsal hump on 4th somite, with paired white spots on each side of it, an indistinct dark dorsal line; lateral area streaked with dark brown.

Wilson[43] describes the larva as follows:

Larva. Long and somewhat slender; segmental divisions distinctly marked; head black, shining, and bifid; 2nd segment large and swollen. Very dark brown, with four ochreous lines down the back, commencing at the 3rd segment; on each side of this series of lines on each segment, is an orange-coloured wart, from which proceed a number of long light hairs; there is also a row of these warts along each side above the spiracles, and below them a number of markings of the same colour; on the 5th segment is a black and shining hump *with a bright white mark on either side of it;* on the 12th segment is a smaller hump of a similar character, with a transverse orange line behind it; spiracles brown encircled with pale buff, legs and claspers behind. *Plate XXIX, fig. 4.*

Food-plants. Poplar, sallow.

Pupa. Amongst the leaves of the food-plant.

Time of appearance. *Larva.* July to October. *Pupa.* October to May. *Imago.* August to May.

(Great Britain, Wilson.)

Grünberg[44] describes the egg and larva as follows:

Egg lentiform, brown-grey with brown transverse band.

Larva reddish grey with grey yellow hair, dark dorsal line and large, interrupted black dorsolateral spots. The tubercle on abdominal segment 1 moderately high, that on segment 8 smaller, brown-red bordered with black, the former accompanied by a prominent white spot. The small orange-red lateral warts weak as in *P. curtula* with which the larva agrees in habits. Pupa rather slender, glossy black-brown, with the segmental incisions of the abdomen red-brown, the apex as in *P. anastomosis.* Cocoon loose, brownish-grey between leaves.

[41] "Yanagi" is apparently used for either sallow or willow in Japanese.

[42] Moths British India 1 (1892) 173.

[43] Larvæ of British Lepidoptera (1880) 193, pl. 29, fig. 4.

[44] Seitz's Macrolep. Faun. Pal. 2 (1912) 315.

My larva agrees well with the preceding description with the exception that the lateral area is strongly marked with a dark, blackish-brown, supraspiracular, longitudinal stripe which appears in my artist's original figure to be continuous and not interrupted.

Sasaki[45] records the life history of *Clostera* [=*Ichthyura*] *anachoreta* Fab. and gives figures and descriptions of the imago and larva. He says that—

> The larva appears in May and feeds on *Yanagi* (Sallow).[46] It is full grown at the commencement of June, and the imago emerges at the end of June.

Nagano[47] records the life history of *Pygaera* [=*Ichthyura*] *anachoreta* Fabricius and gives figures and descriptions of the larva, pupa, cocoon, and imago, male and female. He deduces the following facts from the dates of appearance of the larva and imago of the species.

The imago of the hibernated pupa emerges in April or May of the following year, and oviposits on the trunks of yanagi (sallow or willow). The first brood of larvæ resulting from these ova probably develops the first brood of imagoes in June, July, and August which oviposit a second time, producing a second brood of larvæ, but whether this second brood of larvæ develops the first brood of imagoes next year is not clearly proved. At the end of October, however, full-grown larvæ are to be discovered on the sallow leaves; and it, therefore, seems clear that the species must hibernate in the pupal stage. During this month no cocoons are to be found spun on the sallow twigs as the larvæ appear to spin their cocoons among the withered leaves on the surface of the ground. However this may be, it is evident that the imago of this species seems to have no clearly defined period of emergence, and further investigations are necessary to prove whether there are two or three broods.

Matsumura[48] gives the following trees, in addition to those already mentioned, as food trees of *Pygaera* [=*Ichthyura*] *anachoreta* Fabricius. *Yamanarashi* [Aspen, *Populus tremula*

[45] Nihon Jūmoku Gaichūhen [Insects Injurious to Japanese Trees (Jap.)] ed. 3, pt. 2, 161, pl. 150, larva, imago, ♂.

[46] The name for sallow and willow appears to be the same in Japanese, namely Yanagi.—A. E. W.

[47] Nawa's Insect World (Konchū Sekai) **13** (1909) 445, pl. 21.

[48] Ōyō Konchūgaku (Practical Entomology) ed. 2 (1920) 714 (Jap.).

Linnæus var. *villosa* Wesm.]; *hakuyō* [White poplar, *Populus alba* Linnæus].

Local distribution.—Honshu, Musashi Province, Tokyo, April, (*Wileman*), Yokohama (*Marumo*): Yamato Province, Yoshino, July, September, October (*Wileman*): Kii Province (*Marumo*): Mino Province, Gifu (*Nagano*): Settsu Province, Kobe, April (bred) (*Wileman*). Hokkaido, Oshima Province, Hakodate, June (*Wileman*). Matsumura records this species from Honshu and Hokkaido and Nagano records it from Shikoku and Kyūshū.

Time of appearance.—Larva, April, October, November; imago, April, June, July, September, October. There are probably two or three broods of the imago in the year according to locality and latitude.

Matsumura[49] states that "in Tokyo [Honshu] there are two broods; in Hokkaido there is one brood and in Kyūshū there are three broods."

As Hokkaido is the most northern of these three islands and Kyūshū the most southern, Honshu lying between them, there is approximately a range of over 10° of latitude between these first two islands and therefore a great variation in temperature which would account for the difference in the number of broods.

General distribution.—*Ichthyura anachoreta* Fabricius. From northern Europe, with the exception of the higher latitudes, to northern Italy and northern Spain, southern Russia, Armenia, eastern Asia, China, Japan, India. In central Europe everywhere, but rarer than *curtula* and *anastomosis*, likewise in two broods, April-May and July-August; in the North one brood, May-June. Also in this species (*Pygaera anachoreta* Fabricius) a paler variety, *pallida* Walk., has been separated, which extends from central and eastern Asia into the Oriental Region (*Grünberg*), Manchuria (*Matsumura*), Siberia and Corea (*Marumo*).

ERRATA IN NOTES ON JAPANESE LEPIDOPTERA, PARTS IV, V, AND VI

Philippine Journal of Science 12 § D (1917) No. 4:

Page 230, line 19, *for* Arctiidæ *read* Arctiadæ.
Page 231, line 30, *for* Arctiidæ *read* Arctiadæ.
Page 231, line 31, *for* Lithosiinæ *read* Lithosianæ.
Page 234, line 28, *for* Arctiidæ *read* Arctiadæ.
Page 234, line 29, *for* Arctiinæ *read* Arctianæ.
Page 234, line 40, *for* (1105) *read* (1905).

[49] Loc. cit.

Philippine Journal of Science 12 § D (1917) No. 4—Continued.

Page 235, line 30, *for* Diarcrisia *read* Diacrisia.
Page 238, line 1, *for* Arctiids *read* Arctids.
Page 239, line 1, *for* Leach *read* Leech.
Page 241, line 4, *for* is *read* it.
Page 242, line 33, *for* opulanta *read* opulenta.
Page 244, line 15, *for* Greaser *read* Graeser.
Page 244, line 17, *for* Kashomir *read* Kashmir.
Page 244, line 29, *for* Shikubi *read* Shiokubi.
Page 245, line 15, *for* ocharcea *read* ochracea.

Philippine Journal of Science 13 § D (1918) No. 4:

Page 151, line 7, *for* Lymantriidæ *read* Lymantriadæ.
Page 152, line 7, *for* Ochisenheimer *read* Ochsenheimer.
Page 154, line 17, *for* Higoshi-no-kawa *read* Higashi-no-kawa.
Page 155, line 17, *for* description *read* figure.
Page 155, line 42, *for* Konshū *read* Konchū.
Page 157, line 13, *for* Jumaku *read* Jumoku.
Page 158, line 42, *for* Jumuku *read* Jumoku.
Page 161, line 10, *for* lymantriid *read* lymantrid.
Page 162, line 6, *for* Lymantriidæ *read* Lymantriadæ.
Page 162, line 8, *for* lymantriid *read* lymantrid.
Page 163, line 9, *for* Phal. *read* Pal.
Page 164, line 43, *for* Larvae *read* Larvæ.
Page 165, line 17, *for* Bull. l'Acad *read* Bull. de l'Acad.
Page 167, line 8, *for* "on *read* on.
Page 167, line 15, *for* hairs." *read* hairs.
Page 168, line 8, *for* Apaha *read* Apha.

Philippine Journal of Science 19 (1921) No. 2:

Page 209, *after* line 8 *read* Samia Hübner.
Page 211, line 20, *for* konzui *read* gonzui.
Page 211, line 20, *for* [Latin name unknown, not given by Matsumura in his Shokubutsu Mei-i]. *read* (*Euscaphis japonica* Pax).
Page 216, line 15, *for* hime-yama-nai *read* hime-yamamai.
Page 218, line 36, *for* japoncia *read* japonica.
Page 219, line 25, *for* Dzukei *read* Dzukai.
Page 219, line 27, *for* Jumuko *read* Jumoku.
Page 220, line 36, *for* Ku-su-no-ki *read* Kusunoki.
Page 220, line 39, *for* Populas *read* Populus.
Page 221, line 32, for [*keyaki* read *keyaki* and for (*Zelkowa acuminata* Pl.)] read [*Zelkowa acuminata* Planchon].
Page 221, line 37, *for* He says that *read* He says that:
Page 221, line 38, *for* "in *read* "In.
Page 221, line 39, delete quotation marks.
Page 222, line 13 *for* sale. *read* sale."
Page 223, line 1, *for* Yō hō *read* Yōhō.
Page 224, line 36, *for* Jansai *read* Junsai.
Page 227, line 31, *for* nedzumu-mochi *read* nedzumi-mochi.
Page 228, line 19, *for* wich *read* which.
Page 228, line 21, *for* stmes *read* stems.

ILLUSTRATIONS

[Drawings by Hisashi Kaidō.]

PLATE 1

FIGS. 1 and 2. *Fentonia ocypete* Bremer forma *japonica* Grünberg. *1*, larva; *2*, food plant.

3 and 4. *Cerura milhauseri* Fabricius. *3*, larva; *4*, food plant.

5 to 7. *Lophocosma atriplaga* Staudinger. *5*, larva; *6*, food plant; *7*, head.

8 and 9. *Brachionycoides atrovittatum* Bremer. *8*, larva; *9*, food plant.

10 to 12. *Hyperæschra biloba* Oberthür. *10*, larva; *11*, head; *12*, food plant.

13 and 14. *Ichthyura anachoreta* Fabricius. *13*, larva; *14*, food plant.

PLATE 2

FIGS. 1 and 2. *Drymonia lineata* Oberthür. *1*, larva; *2*, food plant.

3 to 5. *Spatalia macrodonta* Butler. *3*, larva, green form; *4*, larva, violet-gray form; *5*, food plant; *5a*, imago, ♂.

6 to 8. *Lophopteryx saturata* Walker. *6*, larva; *7*, food plant; *8*, anal section, dorsal aspect.

9 to 11. *Euhampsonia cristata* Butler. *9*, larva; *10*, food plant; *11*, head.

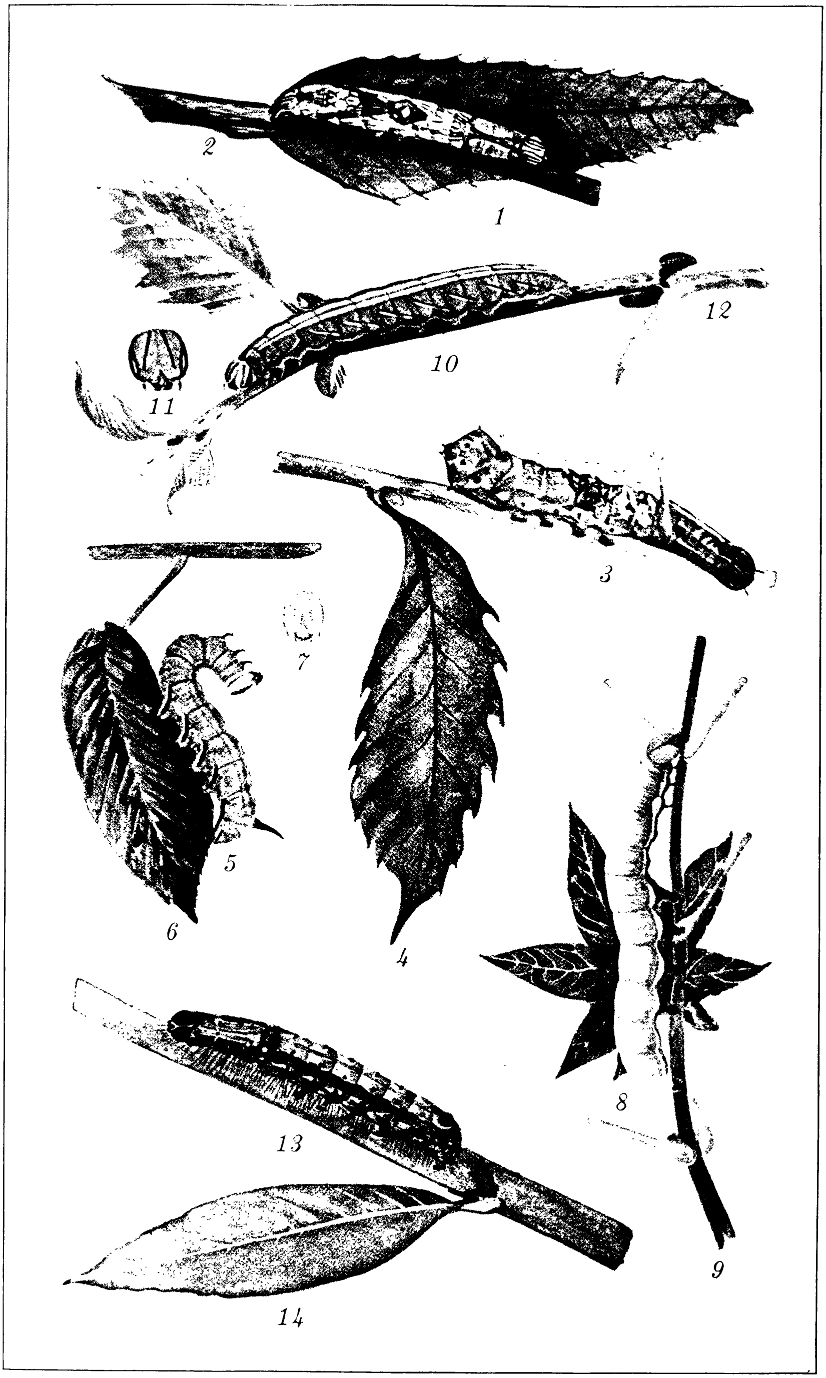


PLATE 1. JAPANESE LEPIDOPTERA.

PLATE 2. JAPANESE LEPIDOPTERA.

VOL. 25, NO. 2 AUGUST, 1924

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1924

203323

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science of the Government of the Philippine Islands

---

Manuscript intended for publication should be sent to the editor. One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Library, Bureau of Science, Manila, P. I.

The Journal is issued twelve times a year. The subscription price is 5 dollars, United States currency, per year. Single numbers, 50 cents each.

Subscriptions may be sent to the BUSINESS MANAGER, Philippine Journal of Science, Bureau of Science, Manila, P. I., or to any of the agents listed on the third page of this cover.

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 25 AUGUST, 1924 No. 2

BIRDS OF ILOCOS NORTE PROVINCE, LUZON

By RICHARD C. MCGREGOR

Ornithologist, Bureau of Science, Manila

Birds were collected by myself and assistants at Bangui, Ilocos Norte Province, Luzon, from October 26 to November 24, 1923; at Piddig, from November 25 to December 6; and at Solsona, from December 7 to December 20.

By means of these collections the known habitat of *Gerygone simplex* and of *Oriolus albiloris* is extended to the north coast of Luzon, *Hyloterpe albiventris* is found to be the common species of its genus in the lowlands of the Ilocos provinces, and *Pericrocotus cinereus, Calliope calliope, Acrocephalus orientalis, Horornis canturiens, Horornis minutus, Anthus cervinus, Emberiza sulphurata,* and *Sturnia philippensis* are established as more or less common winter visitants to the area under consideration.

Luzon, north of San Fernando, La Union Province, differs conspicuously from its central and southern parts in having few coastal indentations large enough to serve as harbors for ocean-going vessels. The coastal plain is comparatively narrow in Ilocos Sur and is pinched out in northern Ilocos Norte by the rocky headland of Cape Bojeador. In central Ilocos Norte the plain extends for many kilometers from the coast to the range of mountains on the eastern provincial boundary.

In the widest part of the plain Laoag River is the main stream of an extensive drainage system. The irrigation systems are extensive and long established. From Laoag good roads extend

to Bangui, Vintar, Piddig, Dingras, Bana, and Solsona. There are substantial bridges over the smaller streams, and the larger rivers are crossed on rafts. The low banks and the extensive beds of gravel suggest the difficulty of building permanent bridges. In many places where bridges have been made at great expense and according to the best engineering practice, some unusual flood has wrecked an approach or undermined one or more of the central piers.

In the northern part of Ilocos Norte Province the area available for rice growing is comparatively limited and is in small areas. The hills and the forests extend nearly to the sea. The climate is different from that of the central part of the province. At Bangui the rice was nearly all harvested by the end of November, while at Piddig and Solsona very little rice had been cut, up to the middle of December.

Bangui is at the end of the automobile road and seemed to offer a good base for the study of migration. It was mainly to pick up, if possible, the line of migration of land or water birds that this place was visited.

In the following enumeration the asterisk is used to indicate species of which specimens were collected. Species not so marked were identified by me in the field with reasonable certainty.

BIRDS OBSERVED IN ILOCOS NORTE PROVINCE

Gallus gallus (Linnæus).

A jungle fowl was seen near the road, many kilometers west of Bangui.

Osmotreron axillaris (Bonaparte).*

Several specimens of the Philippine green pigeon were collected at Bangui and at Piddig.

Osmotreron vernans (Linnæus).*

The pink-necked green pigeon was found at Bangui and at Solsona, but was less abundant than the Philippine green pigeon.

Phapitreron leucotis (Temminck).*

The northern white-eared pigeon was collected at Bangui and at Piddig, but was not abundant.

Macropygia tenuirostris Bonaparte.*

The slender-billed cuckoo dove was noted at Bangui, and two female specimens were collected at Solsona.

Streptopelia dussumieri (Temminck).*

Dussumier's turtle dove was fairly abundant in the three localities visited. Two birds of the year, collected at Solsona on December 9 and 18, respectively, resemble the adult in the color of the upper parts, but the collar is not well marked. The rusty wood brown on the lower throat, breast, and sides is mixed with the light grayish vinaceous of the adult plumage.

Œnopopelia humilis (Temminck).*

The red turtle dove was abundant in the three localities visited. Two young females from Solsona, December 17 and 19, respectively, resemble the adult female, except that the black collar is barely indicated on the sides of the neck. The wing feathers present characteristic signs of immaturity, for the primaries and their coverts are tipped with rusty brown, whereas the secondaries and their coverts and some of the scapulars are tipped with light buff or white.

A nest of this species, containing two fresh eggs, was found at Piddig on December 3. It was situated about 6 meters from the ground in a *duhat* tree, *Eugenia cumini* (Linnæus) Druce. The eggs measure, in millimeters, 25.4 by 19.4 and 26.7 by 19.4, respectively. Another egg was found in the oviduct of a female that was collected on December 14. This egg measures 24.5 by 19.6.

Geopelia striata (Linnæus).*

The barred ground dove was the most abundant dove in the three localities visited. At Solsona, on December 19, two large young birds were found in a nest. The nest is a very slight structure of small plant stems and roots. It measures about 10 centimeters in diameter and was situated about 1 meter from the ground in a brush fence. The young birds are about 13 centimeters in total length. The plumage suggests that of the adult, but the colors of the upper parts are reversed, the ground color being dark brown and the narrow bars on the tips of the feathers being avellaneous to wood brown and fawn color. The chin and upper throat are unfeathered; the breast is pale buff, barred with black; and the abdomen and sides are very pale buff.

Chalcophaps indica (Linnæus).*

Specimens of the Indian bronze-winged dove were collected in the three localities visited. In a female from Solsona the largest feather of the right alula is pure white.

Tachybaptus philippensis (Bonnaterre).

A few Philippine grebes were seen near Bangui.

Pluvialis fulvus (Gmelin).*

Two specimens of the golden plover in winter plumage were collected at Solsona, December 18 and 19, respectively.

Charadrius dubius Scopoli.*

The little ringed plover was seen along various streams, and one specimen was collected at Bangui.

Charadrius alexandrinus Linnæus.*

The Kentish plover was fairly abundant on the seabeach at Bangui, where three specimens were collected late in October.

Actitis hypoleucos (Linnæus).*

Specimens of the common sandpiper were collected at Bangui, and this species was noted at Piddig. No other sandpiper was seen.

Gallinago stenura (Bonaparte).*

A male of the pintail snipe from Solsona, December 13, is the only representative of the genus seen during this trip.

Rostratula capensis (Linnæus).*

A male of the painted snipe was collected at Piddig on December 4.

Egretta garzetta (Linnæus).*

A few little white egrets were seen at Bangui.

Nycticorax nycticorax (Linnæus).*

An immature specimen of the common night heron was collected at Bangui.

Marila fuligula (Linnæus).*

Ducks were reported to be abundant in the vicinity of Bangui, but the only ones seen by us were a male and a female of the tufted duck which we purchased from a local hunter on November 20.

Cerchneis tinnunculus (Linnæus).*

A female hawk, that I identify as a young kestrel, was collected at Bangui on November 16. Whitehead's specimen, from

Lepanto, is the only previous record of the kestrel occurring in Luzon. Perhaps some other specific name should be used for Philippine specimens of this genus.

Bolbopsittacus lunulatus (Scopoli).*

The Luzon guaiabero was fairly abundant at Bangui.

Loriculus philippensis (P. L. S. Müller).*

One colasisi was collected at Bangui.

Alcedo bengalensis Gmelin.*

The common small kingfisher was noted at Bangui and at Piddig.

Halcyon gularis (Kuhl).*

The white-throated kingfisher was noted at Bangui and at Piddig.

Hydrocorax hydrocorax (Linnæus).

The Luzon calao was fairly abundant near Bangui.

Penelopides manillæ (Boddaert).*

The Luzon tarictic was abundant near Bangui.

Merops americanus P. L. S. Müller.*

Specimens of the chestnut-headed beebird were collected at Bangui and at Solsona.

Caprimulgus griseatus Walden.*

The Philippine nightjar was abundant near each of the towns where collections were made. The birds were found resting on the gravel of dry stream beds and could be collected in broad daylight. They were also seen on the wide sandy seabeach at Bangui.

Hemiprocne major (Hartert).*

Whiskered swifts were collected at Bangui.

Cacomantis merulinus (Scopoli).*

The rufous-bellied cuckoo is represented by specimens from Bangui and from Solsona.

Centropus viridis (Scopoli).*

The red-winged coucal is represented by an immature female from Bangui.

Xantholæma hæmacephalum (P. L. S. Müller).*

The yellow-chinned barbet was fairly abundant near Bangui.

Yungipicus validirostris (Blyth).*

Specimens of the large-billed pygmy woodpecker were collected near Bangui.

Chrysocolaptes hæmatribon (Wagler).

No specimen of the golden flicker was collected, but as an individual was watched for several minutes at close range I have no hesitation in adding the name of this species to the Bangui list.

Lichtensteinipicus funebris (Valenciennes).*

A pair of funereal woodpeckers was collected near Bangui.

Pitta erythrogastra Temminck.*

An immature female red-breasted pitta was collected at Bangui.

Cyornis philippinensis Sharpe.*

The Philippine cyornis was found at Bangui.

Gerygone simplex Cabanis.*

Two Philippine gerygones were seen in a small tree several kilometers inland from Burgos, and one of them was killed. This seems to be the most northern record for this erratic species. Another specimen was taken near Piddig.

Hypothymis occipitalis (Vigors).*

This small blue flycatcher occurs in its usual abundance in the vicinity of both Bangui and Piddig.

Rhipidura cyaniceps (Cassin).*

Two specimens of the rufous-bellied fantail were collected at Bangui.

Rhipidura nigritorquis Vigors.

The black and white fantail was noted at Piddig.

Xeocephus rufus (Gray).*

A rufous flycatcher was collected near Solsona.

Eumyias nigrimentalis (Grant).*

Three flycatchers from Solsona appear to be of the same species as numerous skins of *E. nigrimentalis* from the Mountain Province.

Artamides striatus (Boddaert).*

Specimens of the Luzon artamides were collected at Bangui and at Solsona.

Edolisoma cærulescens (Blyth).*

Six specimens of the Luzon cuckoo shrike were collected near Bangui in November.

Pericrocotus cinereus Lafresnaye.*

The ashy minivet was abundant near Bangui late in October and in November. Small flocks were common in trees along roads and in the town.

Lalage melanoleuca (Blyth).*

Two specimens of the black and white lalage were collected at Bangui.

Lalage niger (Forster).*

The pied lalage was fairly abundant at Bangui and at Piddig.

Iole gularis (Pucheran).*

Specimens of the Philippine bulbul were collected at Bangui.

Pycnonotus goiavier (Scopoli).

The guava bulbul was noted at Bangui and at Piddig.

Petrophila manillensis (J. R. Forster).*

The eastern rock thrush was abundant in the vicinity of Bangui.

Calliope calliope (Pallas).*

The Siberian rubythroat was abundant at Piddig and at Solsona. It was first noted on December 2. A dozen specimens were collected, more than all the specimens in the Bureau of Science collection.

Copsychus mindanensis (Boddaert).*

The dominico was noted at Bangui and at Piddig.

Kittacincla luzoniensis (Kittlitz).*

The Luzon shama was fairly abundant in the vicinity of Bangui.

Pratincola caprata (Linnæus).*

The pied chat was noted in each of the localities visited.

Acrocephalus orientalis (Temminck and Schlegel).*

The oriental reed warbler is represented by two males, one of them collected at Piddig, December 6; the other, at Solsona, December 15.

Orthotomus chloronotus Grant.*

Specimens of the green-backed tailorbird were collected at Bangui.

Megalurus palustris Horsfield.*

The striated marsh warbler was noted at the three localities visited, and specimens were collected at Piddig and at Solsona.

Megalurus tweeddalei McGregor.*

A specimen of Tweeddale's marsh warbler was collected at Bangui.

Acanthopneuste borealis (Blasius).*

The northern willow warbler was abundant at Bangui, and specimens were collected at Piddig and at Solsona.

Acanthopneuste xanthodryas (Swinhoe).*

Two males of the yellow willow warbler were taken at Bangui, November 11 and 23, respectively.

Horornis canturiens (Swinhoe).*

The Chinese bush warbler was collected at Piddig on November 26 and December 6 and at Solsona on December 8, 9, and 10. All of the five specimens are males.

Horornis minutus (Swinhoe).*

The little bush warbler is represented by three males and four females. The first specimen was collected at Bangui on November 21; the next was collected at Piddig on November 30; four were collected at Piddig on December 6; the last one was taken at Solsona on December 19. This is the first Luzon record for the species.

Artamus leucorynchus (Linnæus).

Swallow shrikes were noted at Bangui and at Piddig.

Cephalophoneus nasutus (Scopoli).*

The large-nosed shrike was noted at Bangui and was fairly abundant in the vicinity of Piddig.

Otomela lucionensis (Linnæus).*

The gray-headed shrike was noted at Bangui and at Piddig.

Hyloterpe albiventris Grant.*

Thickheads were fairly abundant at Piddig and at Solsona; less so at Bangui. Comparison of a dozen specimens from these localities with typical *H. albiventris* from Irisan and Pauai, Mountain Province, shows no differences that may not well be due to difference in season. The Ilocos specimens (November and December) are in fresh plumage, and the Mountain Province birds (April and May) are somewhat worn.

Pardaliparus elegans (Lesson).*

The elegant titmouse was seen at Bangui only, where a pair of adults and an immature bird were taken in November.

Rhabdornis mystacalis (Temminck).*

Five specimens of the Philippine creeper were collected at Bangui.

Zosterops aureiloris Grant.*

Silvereyes were collected in the three localities visited; probably they are *Z. aureiloris,* but I am not certain what that species is.

Dicæum papuense (Gmelin).*

Four specimens of the Philippine flowerpecker were collected at Bangui.

Dicæum pygmæum (Kittlitz).*

Specimens of the pygmy flowerpecker were collected at Bangui and at Solsona.

Prionochilus inexpectatus Hartert.*

A female flowerpecker from Solsona, December 8, belongs to this species.

Piprisoma æruginosum (Bourns and Worcester).*

Four specimens of the rusty flowerpecker were collected at Solsona. Sharpe transferred this species to *Acmonorhynchus* Oates, which was based on a Ceylonese species. I doubt that the two are congeneric.

Leptocoma henkei (Meyer).*

Henke's sunbird was fairly abundant at Bangui and at Piddig.

Cyrtostomus jugularis (Linnæus).*

A male of the yellow-breasted sunbird was collected at Solsona, and two specimens were collected at Piddig.

Anthreptes griseigularis Tweeddale.*

A male and two females of the gray-throated sunbird were collected at Piddig.

Motacilla melanope Pallas.*

A specimen of the gray wagtail was collected at Bangui on October 28, and others were seen near Piddig and near Solsona.

Budytes leucostriatus Homeyer.*

A male of the Siberian yellow wagtail was collected at Bangui on November 16.

Anthus rufulus Vieillot.*

The Indian pipit was noted at each of the localities visited, and two specimens were collected at Solsona.

Anthus gustavi Swinhoe.*

Two specimens of the Petchora pipit were collected at Bangui; others were seen in the same locality.

Anthus cervinus (Pallas).*

Two specimens of the red-throated pipit were collected at Bangui on November 17, and one was collected on December 14. In November, 1903, we found this species abundant on Calayan.

Passer montanus (Linnæus).

The tree sparrow was noted at Bangui and at Piddig.

Emberiza sulphurata Temminck and Schlegel.*

A male of the Japanese yellow bunting was collected at Bangui on November 15; another male was collected on the 17th. In December, both males and females were abundant at Piddig and at Solsona. Near the latter town buntings were seen every day along roads and in uncultivated fields.

Padda oryzivora (Linnæus).*

A few Java sparrows were seen about the town of Bangui.

Munia jagori Martens.

The Philippine weaver was noted at Bangui and at Piddig.

Munia cabanisi Sharpe.

This species was noted at Bangui only. On November 15 seven Cabanis's weavers were noted in a field on the heads of rice; on the 19th four birds of this species were seen in a river bed picking up rice.

Oriolus acrorhynchus Vigors.*

The Philippine oriole was fairly abundant in the localities visited by us.

Oriolus albiloris Grant.*

The white-lored oriole was seen several times in the forest near Bangui; a female was collected on November 7.

Dicrurus balicassius (Linnæus).*

The northern drongo was fairly abundant at Bangui.

Sturnia philippensis (Forster).*

A female violet-backed starling was collected at Bangui on October 28.

Sarcops calvus (Linnæus).*

Coletos were noted at Bangui and at Piddig. A male collected at Bangui on October 30 is nearer to *S. calvus* than to *S. melanonotus*.

Corvus philippinus Bonaparte.

The Philippine crow was noted in each of the localities visited.

CHEMOTHERAPEUTIC EXPERIMENTS WITH CHAULMOOGRA AND ALLIED PREPARATIONS

IV. A SURVEY OF CERTAIN ORGANIC COMPOUNDS AS TO THEIR GROWTH-INHIBITING ACTIVITY TOWARD ACID-FAST BACILLI IN VITRO

By OTTO SCHÖBL [1]

Of the Serum Laboratory, Bureau of Science, Manila

It was the aim of the following experiments to survey certain organic compounds, belonging to various groups, with regard to their growth-inhibiting activity toward acid-fast bacilli. It is reasonable to expect that certain organic compounds, highly active chemically, such as the aldehydes, nitro, and hydroxy compounds, will be found strongly antiseptic toward the acid-fast bacilli, as they are so toward other bacteria. Nevertheless, in view of the peculiar selective antiseptic activity of the acids from the chaulmoogric series as well as the unique chemical composition of these bacilli it became highly desirable in the course of our investigation to know if and how far the growth-inhibiting activity of organic compounds follows the known rules that govern the interdependency of chemical structure of organic compounds and their physiologic effect.

Furthermore, there were found indications of semiselective inhibitory action of the constituents of certain volatile oils which made the present survey all the more desirable. It is regretted that the collection of available compounds was not more complete. Thanks are due to the members of the division of organic chemistry, Bureau of Science, and of the department of chemistry, University of the Philippines, for supplying the compounds as well as for their coöperation and advice in the preparation of this paper.

The early investigations of Bechhold and Ehrlich [2] revealed the most varied changes in action when the substituents of phenols varied. Unfortunately, as a rule, with the increase of the antiseptic activity of an aromatic compound, its toxicity increases also, but not necessarily in the same proportion. These authors

[1] Member, Philippine Leprosy Research Board.
[2] Zeitschr. für Physiol. Chem. 47 (1906) 173.

investigated phenols and used *Bacillus diphtheriæ*, extending their experiments in certain instances to *Bacillus coli*, *B. pyocyaneus*, *B. typhosus*, *Streptococcus*, and *Staphylococcus*.

The general rules as to the antiseptic activity of aromatic compounds can be briefly summarized as follows:

1. The introduction of halogen (Cl, Br) into the nucleus of phenols increases the disinfecting activity of the compound in proportion with the number of halogen atoms.

2. The introduction of alkyl groups in the presence of halogen in the molecule increases the antiseptic activity.

3. Combination of two phenols affects the antiseptic activity as follows:

(*a*) Direct; increases.
(*b*) By CH_2; increases.
(*c*) By COOH; increases.
(*d*) By CHOR; increases.
(*e*) By CO; diminishes.
(*f*) By SO_2; diminishes.

The compounds investigated by me are listed in the appended tables and are arranged according to the chemical groups to which they belong; namely, acids, alcohols, aldehydes, hydrocarbons, amino compounds, phenols, ethers, and terpenes.

TECHNIC OF EXPERIMENTATION

The same technic of testing was used in these experiments as that described in a previous paper.[3] Liquids were added to the melted agar in 100 per cent concentration. Substances melting at or below 100° C. were also added in that concentration, while kept on the water bath, by means of hot pipettes. Otherwise, the chemicals were used in concentrated solution (100° C.) as a starting solution. Dilutions were made either in water or in olive oil, according to the solubility of the particular compound.

The medicated tubes were planted with a young rapidly growing culture of *Bacillus tuberculosis*, sealed with paraffine and incubated, and readings made two and four weeks after planting. The smallest amount of a particular chemical which, added to the tube, produced inhibition of growth was designated as titer while the figures given in the tables as value give the relative strength, 1 per cent concentration being taken as one unit. It is evident at once that a precise titration of the growth-inhibiting effect of the compounds was not attempted. Dilutions were made at long intervals and, as a result, considerable differences in effect may have remained unnoticed, particularly with compounds that gave

[3] Philip. Journ. Sci. **23** (1923) 533.

values of 20 or more. On account of the procedure used, the figures given as titer represent the amount by volume, not always of the pure compound, but often of the saturated solution at 100° C. of the compound. The factor of solubility was therefore allowed free play. No doubt, such procedure accounts for the differences in our results as compared with those obtained by others—for instance, in the phenol group. The survey includes numerous chemicals belonging to various and sometimes unrelated groups in the system of organic chemistry. The results obtained by this method of experimentation show the relation between the chemical structure of the compounds and their antiseptic effect as modified by their solubility more plainly than do the results obtained by other workers who disregarded the factor of solubility. It will be seen that the rules deduced from my experiments, of the relation between the chemical composition and the antiseptic effect of organic compounds, agree with those of chemical reactivity and physiological effect.

Table 1 gives the results of tests performed with organic acids. They were tested in the form of slightly alkaline soaps. It can be seen from this table that the antiseptic activity of these soaps, starting with that of formic acid, is comparatively high in the case of the first few members of the series; that is, the water-soluble acids. Then it decreases rather rapidly, beginning with valeric, with the increase of the CH_2 groups, up to stearic acid. Of the dibasic acids none showed noteworthy growth-inhibiting activity as far as tested.

Tests performed with some derivatives of acetic acid are presented in Table 2. Acetic acid was selected for the study of the effect on the growth-inhibiting activity of the introduction of various elements and groups, because it is one of the acids which showed moderately high effect, so that an increase as well as a decrease could be seen. Furthermore, more derivatives of this acid were available than of any other from this series.

Table 2 shows that sodium, copper, and nickel salts of acetic acid are about equally effective, while zinc, strontium, lead, and uranium compounds show no effect. Dichloracetic acid has a value of at least 20; that is, twice the strength of sodium acetate, while trichloracetic was about equal to sodium copper or nickel acetate (about 10). Potassium chloracetic acid has about the same value as dichloracetic but acetamid and trichloracetamid are considerably lower (less than 2).

Of the organic derivatives of acetic acid, methyl and benzyl compounds are without much effect; bornyl showed slight effect

(more than 1); but phenyl surpassed all other derivatives tested (about 100).

In the series of aromatic carboxy acids (Table 1), benzoic acid gave a value of less than 1, showing that the carboxyl group attached directly did not release the antiseptic effect inherent in the benzol ring. A hydroxyl group in ortho position to carboxyl on the ring raises the antiseptic effect in salicylic acid somewhat more than it does on the side chain in mandelic acid. It remains insignificant in oxycinnamic (cummaric) acid where the OH group is on the ring and a carboxyl is bound to the ring by a double-bonded group CH=CH on the side chain. On the other hand, in cinnamic acid, where the carboxyl is linked to a phenyl group by a double-bonded group CH=CH, the antiseptic effect rises to 100. Evidently the phenyl group in the latter acid develops its full antiseptic effect, which is not the case with oxycinnamic acid; nor can the phenyl in hydrocinnamic acid act fully, although present, owing to the absence of the double bond.

The esters of organic acids (Table 3) proved to be of low antiseptic value. Such inhibition as was noticed in certain instances was only partial, although to rather high dilution. The experience that esters (of chaulmoogra oil, for instance) give no complete inhibition of growth in low dilutions, but that partial inhibition of growth is noticeable in low and high dilutions can be explained by what can be termed the storage effect of the esters. The growing bacilli split the ester and a small amount of the growth-inhibiting acid is set free. The liberated amount of the acid is not sufficient completely to stop the growth but a lag results in the multiplication of bacilli.

It is evident from Table 4 (alcohols) that the growth-inhibiting activity of the saturated alcohols, from methyl to melissyl, is insignificant (less than 1). Butyl alcohol gave higher value than isobutyl, and primary octyl alcohol likewise showed slightly higher inhibition than the corresponding secondary alcohol.

Phenyl ethyl alcohol, both primary and secondary, gave value 2. The unsaturated allyl alcohol gave value 2, but the phenyl allyl alcohol inhibited growth in as high a dilution as benzyl alcohol (more than 20) which is a value somewhat higher than that of phenol.

As was expected, the growth-inhibiting effect of aldehydes is considerable (Table 5). Compared with the well-known formaldehyde, which found practical application in medicine, the pleasant-smelling and nonirritating benzaldehyde and, particu-

larly, the cinnamyl aldehyde surpass formaldehyde in growth-inhibiting action toward acid-fast bacilli.

It was noticed in the series of alcohols tested that unsaturated alcohols which are good fat solvents had little or no growth-inhibiting effect upon acid-fast bacilli. Strong hypnotics, like some of the members of the series given in Table 6, which are at the same time strong fat solvents, have not such growth-inhibiting effect as one might expect, considering the chemical composition of acid-fast bacilli.

The results of tests performed with certain nitro compounds are given in Table 7. The most striking finding is the great difference between the effect of aniline and benzylamine. The behavior of the amino group is apparently quite the reverse of that of the alkyl group with regard to the influence it has on the antiseptic effect of the benzol ring. While the alkyl increases the antiseptic effect of phenol when located on the ring, it has quite the reverse effect when on the side chain; but the differences are far greater in case of the amino group and the effect is reversed. Aniline showed hardly any effect at all (less than 1) while benzylamine tested more than a hundred times stronger. The aniline being without effect (less than 1) the alkylation of the amino group does not affect its antiseptic activity. Further introduction into aniline of an amino group raises its activity somewhat even in para position, as in paraphenylenediamine (more than 2). The NH_2 group linked to a phenyl by CH_2 in benzylamine gave a value of more than 100, while the strongly mitigating effect of carbonyl is evident in benzamide (about 1). The NH_2 group in benzylamine acts evidently as a haptophore group, bringing out the strongly toxic effect of the phenyl group.

Table 8 (on phenols) gives the results of tests with certain organic hydroxy compounds. The monohydroxy phenol gave a value of 20; both meta and para dihydroxyphenol inhibited to about the same degree, slightly below the value of phenol; but the orthodihydroxyphenol gave a higher value than mono phenol or meta or para dihydroxyphenol. The 1, 2, 3 trihydroxyphenol gave a value of more than 100. On the other hand, phloroglucinol which is 1, 3, 5 trihydroxyphenol was found practically inactive. The alkylation on the ring in phenol increased the antiseptic effect, particularly in orthocresol. Double alkylation of phenol on the ring with methyl and isopropyl increased the antiseptic value, as shown by the results for carvacrol.

Anisol (Table 8, on ethers), which has a methyl and phenyl group linked by O, gave value 2, showing that methylation of

the hydroxy group in phenol decreases the effect, whereas alkylation on the ring in cresols increases it. In dihydroxyphenols the alkylation, of one OH only, has apparently little effect on the growth-inhibiting action as shown by the guajacol value (more than 100). Complete methylation of hydroxyls decreases the growth-inhibiting activity in dihydroxyphenol (veratrol). The introduction into the mono methyl ether of the $CH_2CH{=}CH_2$ group (vanilin) evidently decreases its effect.

Table 9 (terpenes) shows the open-chain compounds citral, citronellal, and linalool to be equally effective and about ten times more effective than their cyclic isomers. Compare citral (20) with pulegone (more than 2); linalool and citronellal (20) with terpineol (less than 1).

Among the cyclic compounds carvone tested somewhat stronger than phenol. Carvene showed only slight inhibitory effect, whereas pulegone and menthol gave a value of more than 2. Terpineol proved to be practically ineffective.

SUMMARY

1. Water-soluble compounds showed an antiseptic effect, whereas the fat solvents such as benzol, toluol, xylol, carbon trichloride, and carbon tetrachloride which have a strong hypnotic effect were found to be only slightly antiseptic or not at all.

2. Sodium, copper, and nickel salts of fatty acids were found about equally effective whereas zinc, strontium, lead, and uranium salts showed no effect.

3. The double-bond-containing compounds all showed antiseptic effect, the double bond being more effective on the side chain than on the ring in aromatic compounds.

4. Unsaturated alcohols showed an antiseptic effect, particularly when containing the phenyl group which proved to be the most powerful toxic group.

5. High alcohols approaching waxes showed no effect. Secondary alcohols were equally or less effective than primary alcohols.

6. Hydroxy compounds are highly antiseptic toward acid-fast organisms, as they are toward other bacteria.

7. The antiseptic effect of phenols increases with the number of hydroxyl groups, the position of these groups being of importance, as the ortho compounds are more antiseptic than the para or meta compounds.

8. Alkylation on the ring increases the antiseptic effect of phenols, whereas alkylation on the OH group of polyhydroxy-

phenols has no noteworthy effect, provided at least one hydroxyl is preserved free.

9. The amino group (NH_2) has a reverse effect on the antiseptic power of the aromatic compounds, in as much as it has no effect when located on the ring but is strongly antiseptic when linked to the ring directly on the side chain. It acts as a haptophore group and the strong effect of benzylamine is no doubt due to the function of the phenyl group.

10. Open-chain terpenes are more effective than their cyclic isomers.

11. In the cyclic hydrocarbons the double bond in the ring seems to be of importance in the presence of other groups on the ring, but not in itself.

TABLE 1.—*Results of growth-inhibiting tests with organic acids.*

Name of acid.	Chemical formula.	Growth-inhibiting value.
Formic	$H\ COOH$	> 10
Acetic	$CH_3\ COOH$	10
Propionic	$CH_2\ (CH_2)\ COOH$	10
Butyric	$CH_3\ (CH_2)_2\ COOH$	10
Valeric	$CH_3\ (CH_2)_3\ COOH$	< 1
Caprylic	$CH_3\ (CH_2)_6\ COOH$	2
Lauric	$CH_3\ (CH_2)_{10}\ COOH$	> 2
Myristic	$CH_3\ (CH_2)_{12}\ COOH$	> 1
Palmitic	$CH_3\ (CH_2)_{14}\ COOH$	< 1
Stearic	$CH_3\ (CH_2)_{16}\ COOH$	< 1
Crotonic	$CH_3\ CH=CH\ COOH$	< 2
Oleic	$CH_3\ (CH_2)_7\ CH=CH(CH_2)_7\ COOH$	> 2
Oxalic	$COOH$ $COOH$	< 1
Succinic	$CH_2\ COOH$ $CH_2\ COOH$	< 1
Citric	$CH_2\ COOH$ $C(OH)\ COOH$ $CH_2\ COOH$	< 1
Malic	$CH_2\ COOH$ $CH(OH)\ COOH$	< 1
Tartaric	$CH(OH)\ COOH$ $CH(OH)\ COOH$	< 1
Benzoic	$C_6H_5\ COOH$	< 1
Hydrocinnamic	$C_6H_5\ CH_2\ CH_2\ COOH$	< 1
Cinnamic	$C_6H_5\ CH=CH\ COOH$	>100
Oxycinnamic	$C_6H_4(OH)\ CH=CH\ COOH$	< 1
Mandelic	$C_6H_5\ CH(OH)\ COOH$	> 1
Salicylic	(O) $C_6H_4(OH)\ COOH$	> 2
Gallic	$C_6H_2(OH)_3\ COOH$	2
Tannic	$C_{14}\ H_{10}\ O_9$	< 10
Phthalic	(O) $C_6H_4\ (COOH)_2$	> 1
Terephthalic	(P) $C_6H_4\ (COOH)_2$	< 1

TABLE 2.—*Results of growth-inhibiting experiments with certain derivatives of acetic acid.*

Name of compound.	Growth-inhibiting value.
Sodium acetate	< 10
Copper acetate	< 10
Nickel acetate	< 10
Zinc acetate	< 1
Strontium acetate	< 1
Lead acetate	< 1
Basic lead acetate	< 1
Uranyl acetate	< 1
Potassium chloracetic acid	<100
Dichloracetic acid	<100
Trichloracetic acid	< 10
Acetamid	< 2
Trichloracetamid	< 2
Methyl acetate	< 1
Benzyl acetate	< 1
Phenyl acetate	100
Bornyl acetate	< 2

TABLE 3.—*Results of growth-inhibiting tests with esters of organic acids.*

Name of compound.	Chemical formula.	Growth-inhibiting value.
Methyl valeate	$CH_3(CH_2)_3\ COOCH_3$	< 1
Ethyl lactate	$CH_3\ CH(CH)\ COOC_2H_5$	< 1
Methylbenzoate	$C_6H_5COOCH_3$	
Ethylanisate	$C_6H_4 \begin{cases} OCH_3 \\ COOC_2H_5 \end{cases}$	< 1
Ethyl glycolate	$CH_2 \begin{cases} OH \\ COOC_2H_5 \end{cases}$	< 2
Ethyl ester, cod-liver oil		< 1
Ethyl ester, chaulmoogra oil		> 1
Ethyl ester, chaulmoogric acid		1
Allyl ester, chaulmoogric acid		> 1
Capryl ester, chaulmoogric acid		< 1

TABLE 4.—*Results of growth-inhibiting experiments with alcohols.*

Name of alcohol.	Chemical formula.	Growth-inhibiting value.
Methyl	CH_3 OH	< 1
Ethyl	C_2H_5 OH	< 1
Propyl	C_3H_7 OH	< 1
Isopropyl	CH_3–CH OH–CH_3	< 1
Butyl	C_4H_9 OH	1
Isobutyl	$(CH_3)_2$ CH CH_2 OH	< 1
Heptyl	CH_3 $(CH_2)_5$ CH_2 OH	< 1
Octyl, normal	CH_3 $(CH_2)_6$ CH_2 OH	1
Octyl, secondary		< 1
Cetyl	CH_3 $(CH_2)_{14}$ CH_2 OH	< 1
Melissyl	C_{30} H_{61} OH	< 1
Piperonyl	$CH_2<_O^O>C_6H_3CH_2$ OH	1
Phenyl ethyl, primary	C_6H_5 CH_2 CH_2 OH	2
Phenyl ethyl, secondary	C_6H_5 CH OH CH_3	2
Allyl	CH_2=CH CH_2 OH	2
Phenyl allyl	C_6H_5 CH=CH CH_2 OH	> 20
Benzyl	C_6H_5 CH_2 OH	> 20

TABLE 5.—*Results of growth-inhibiting tests with aldehydes.*

Name of compound.	Chemical formula.	Growth-inhibiting value.
Formaldehyde	$\overset{O}{H.C\,H}$	> 10
Cinnamyl aldehyde	C_6H_5. CH=CH CHO	<500
Benzaldehyde	C_6H_5 CHO	20
Isopropylbenzaldehyde	$(CH_3)_2$ CH C_6H_4 CHO. (1)	< 10

TABLE 6.—*Results of growth-inhibiting experiments with hydrocarbons, their halogen and other derivatives.*

Name of compound.	Chemical formula.	Growth-inhibiting value.
Benzol	C_6H_6	< 1
Toluol	$C_6H_5\ CH_3$	< 1
Xylol	$C_6H_4\ (CH_3)_2$	1
Carbon trichloride	$CH\ Cl_3$	< 1
Carbon tetrachloride	$C\ Cl_4$	10
Ethylene bromide	$\left\{\begin{matrix} CH_2\ Br \\ CH_2\ Br \end{matrix}\right.$	2
Brombenzol	$C_6H_5\ Br$	2
Ethylbenzol	$C_6H_5\ CH_2\ CH_3$	1
Benzylbromide	$C_6H_5\ CH_2\ Br$	
Naphthaline	$C_{10}\ H_8$	
A-Naphthol	$C_{10}\ H_7\ OH$	1
B-Naphthol	$C_{10}\ H_7\ OH$	> 1

TABLE 7.—*Results of growth-inhibiting tests with nitro compounds.*

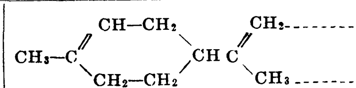
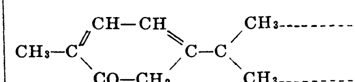
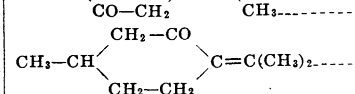
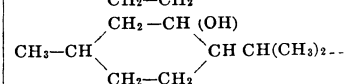
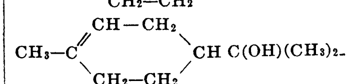
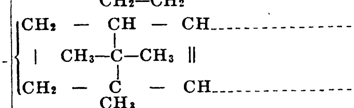
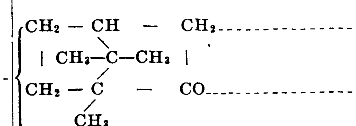
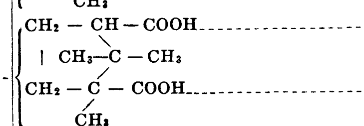
Name of compound.	Chemical formula.	Growth-inhibiting value.
Urea	$NH_2\ CO\ NH_2$	< 1
Ethylamine	$C_2H_5\ NH_2$	> 10
Diethylamine	$(C_2H_5)_2\ NH$	> 10
Diphenylamine	$(C_6H_5)_2\ NH$	> 10
Paraphenylenediamine	$C_6H_4 \begin{matrix} \diagup NH_2\ (1) \\ \diagdown NH_2\ (4) \end{matrix}$	> 2
Benzylamine	$C_6H_5\ CH_2.\ NH_2$	>100
B-Naphthylamine	$C_{10}\ H_7\ NH_2$	> 10
Benzamide	$C_6H_5\ CO\ NH_2$	1
Aniline	$C_6H_5\ NH_2$	< 1
Dimethylaniline	$C_6H_5\ N(CH_3)_2$	< 1
Picric acid	$C_6H_2\ OH\ (NO_2)_3$ (1, 2, 4, 6.)	< 1
(O) Amidobenzoicacid	$C_6H_4 \begin{matrix} \diagup NH_2 \\ \diagdown COOH \end{matrix}$	1
(P) Amidobenzoicacid	$C_6H_4 \begin{matrix} \diagup NH_2 \\ \diagdown COOH \end{matrix}$	< 1
(M) Amidobenzoicacid	$C_6H_4 \begin{matrix} \diagup NH_2 \\ \diagdown COOH \end{matrix}$	< 1
Pyridine	$C_5H_5\ N$	< 10

TABLE 8.—*Results of growth-inhibiting experiments with phenols and ethers.*

Name of compound.	Chemical formula.	Growth-inhibiting value.
Phenol	$C_6H_5\text{-}OH$	20
Cresol, ortho	(o) $C_6H_4 \left\langle \begin{matrix} CH_3 (1) \\ OH\ (2) \end{matrix} \right.$	100
Cresol, meta	(m) $C_6H_4 \left\langle \begin{matrix} CH_3\ (1) \\ OH\ (3) \end{matrix} \right.$	20
Cresol, para	(p) $C_6H_4 \left\langle \begin{matrix} CH_3\ (1) \\ OH\ (4) \end{matrix} \right.$	20
Carvacrol	$C_6H_3 \left\langle \begin{matrix} CH_3\ (1) \\ OH\ (3) \\ CH\ (CH_3)_2\ (4) \end{matrix} \right.$	> 20
Catechol	(O) $C_6H_4 \left\langle \begin{matrix} OH\ (1) \\ OH\ (2) \end{matrix} \right.$	< 200
Resorsinol	$C_6H_4 \left\langle \begin{matrix} OH\ (1) \\ OH\ (3) \end{matrix} \right.$	> 10
Hydrochinon	$C_6H_4 \left\langle \begin{matrix} OH\ (1) \\ OH\ (4) \end{matrix} \right.$	> 10
Pyrogallol	$C_6H_3 \left\langle \begin{matrix} OH\ (1) \\ OH\ (2) \\ OH\ (3) \end{matrix} \right.$	< 200
Phloroglucinol	$C_6H_3 \left\langle \begin{matrix} OH\ (1) \\ OH\ (3) \\ OH\ (5) \end{matrix} \right.$	< 1
Anisol	$C_6H_5\text{-}O\text{-}CH_3$	2
Guajacol	(O) $C_6H_4 \left\langle \begin{matrix} OH\ (1) \\ OCH_3\ (2) \end{matrix} \right.$	> 100
Veratrol	(o) $C_6H_4 \left\langle \begin{matrix} OCH_3\ (1) \\ OCH_3\ (2) \end{matrix} \right.$	< 20
Eugenol	$C_6H_3 \left\langle \begin{matrix} OH\ (1) \\ OCH_3\ (2) \\ CH_2CH{=}CH_2\ (4) \end{matrix} \right.$	> 20
Vanilin	$C_6H_3 \left\langle \begin{matrix} OH\ (4) \\ O\ CH_3\ (3) \\ CHO\ (1) \end{matrix} \right.$	> 10
Safrol	$C_6H_3 \left\langle \begin{matrix} CH_2\ CH{=}CH_2\ (1) \\ O\ CH_2\ (3) \\ O\ \ \ \ (4) \end{matrix} \right.$	10
Anethol	(P) $C_6H_4 \left\langle \begin{matrix} O\ CH_3 \\ CH{=}CH\ CH_3 \end{matrix} \right.$	< 1

TABLE 9.—*Results of growth-inhibiting tests with terpenes.*

TERPENES

Name of compound.	Chemical formula.	Growth-inhibiting value.
Citral	$(CH_3)_2\ C{=}CH\ (CH_2)_2\ C(CH_3){=}CH\ CHO$.	20
Citronellal	$CH_2{=}C(CH_3)\ (CH_2)_3CH(CH_3)\ CH_2CHO$	20
Linalool	$(CH_3)_2\ C{=}CH\ (CH_2)_2\ C(CH_3)\ (OH)\ CH{=}CH_2$	20
CYCLIC TERPENES		
Carvene		1
Carvone		>20
Pulegone		> 2
Menthol		> 2
Terpineol		< 1
Camphene		< 1
Camphor		> 2
Camphoric acid		< 1

CHEMOTHERAPEUTIC EXPERIMENTS WITH CHAULMOOGRA AND ALLIED PREPARATIONS

V. AN INQUIRY INTO THE MECHANISM AND NATURE OF THE GROWTH-INHIBITING EFFECT OF CHAULMOOGRA AND OTHER VEGETABLE OILS

By OTTO SCHÖBL[1]

Of the Serum Laboratory, Bureau of Science, Manila

From the many problems which undoubtedly are involved in chaulmoogra therapy I have selected and isolated from the others one which, being fundamental in chemotherapeutics, is at the same time accessible to solution by laboratory experimentation; that is, the direct action of the oil or its constituents upon acid-fast bacteria.

The pioneer work of Walker and Sweeney[2] brought about a better understanding of the working of this useful drug in that these authors pointed out particularly the specificity of chaulmoogra toward acid-fast bacteria, an activity of the acids from the chaulmoogric series which is lacking in other oils. Therefore, it is reasonable to conclude that any therapeutic result, achieved by the use of oils and fats other than chaulmoogric acid, must be interpreted as having been accomplished by means of some of the other factors than the direct selective antiseptic action upon the acid-fast bacteria and need not necessarily be underestimated.

It was the object of the previous and the present investigations to enlarge, if possible, on the information already furnished by the work of Walker and Sweeney, further to probe the feasibility of Walker's explanation of the direct action of chaulmoogric acids upon the acid-fast bacteria and, if this theory should be found supported by experimental evidence, to search for the particular "group or arrangement of atoms which is toxic for the bacterial cell" (Walker).[2]

[1] Member, Philippine Leprosy Research Board.

[2] The chemotherapeutics of the chaulmoogric acid series and other fatty acids in leprosy and tuberculosis, Journ. Inf. Dis. 1 (1920) 1.

This problem was approached by a study of the growth-inhibiting activity of chaulmoogric acids in which the arrangement of atoms has been changed or new elements or groups introduced and, furthermore, by a similar study of chemicals from the hydroaromatic group having various arrangements of the hydrocarbon ring to a certain extent similar to the structure of the ring in the formula of chaulmoogric acids as suggested by Barrowcliff and Powers.[3]

In judging the growth-inhibiting effect of oils and like substances in vitro one must consider factors which might be responsible for the nondevelopment or the scanty growth on a culture medium to which the substances have been added.

First is the mechanical factor. In using solid media and a large amount of oily substance the minute droplets may come so close together that they displace the culture medium proper, and for that and concomitant reasons the conditions become unfavorable for the growth of the particular bacterium. It is therefore advisable not to use too high a concentration of the oil in making tests.

Another factor is the possible high degree of acidity of the particular oil which may bring the reaction of the culture medium beyond the maximum acidity limit of growth. The possible errors due to this factor can be eliminated if one controls the results obtained in the oils by tests with corresponding alkaline soaps.

In the case of a drying oil, particularly, the fact must be considered that, during the process of drying, the oil may use up a considerable amount of oxygen and thus render the atmosphere in a closed tube anærobic. Furthermore, secondary volatile products are given off during the process of drying which in themselves may be or are known to be antiseptic.

For instance, according to Friend,[4] the bulk of the vapors evolved during the drying of linseed oil is water; but carbon dioxide, carbon monoxide, formic, butyric, acetic, and acrylic acids have also been detected. Furthermore, the factor of solubility of the active principle enters, as do also the chemical changes which the active principle undergoes on standing and during the performance of the test itself.

[3] Journ. Chem. Soc. 87 (1905) 884.

[4] The Chemistry of Linseed Oil. London, Gurney and Jackson (1917) 50.

An illustration of the interference of the factor of solubility with the results of inhibition tests is found in the experiments reported in an earlier paper.[5]

Chaulmoogra oil showed an inhibitory titer of 0.05; that is to say, 0.05 cubic centimenter of the oil added to 10 cubic centimeters of agar inhibited completely the growth of *Bacillus tuberculosis*. The easily soluble sodium salt of the total fatty acids of the same oil, in a 3 per cent solution, gave a titer of 0.01. Recalculated, it brings the titer of total fatty acids in the form of soluble soap to about 0.0003, which is a much higher inhibitory effect than the calculated titer of the total fatty acids in the form of oil. Naturally, the action of sodium gynocardate as a soap enters also.

On the other hand, the inhibiting effect of sodium chaulmoograte was found to be considerably lower than that of the hydnocarpate. This fact might lead to the erroneous conclusion that chaulmoogric acid is an inferior constituent of the chaulmoogra oil, but such conclusion is contradicted by the finding that *Hydnocarpus alcalæ* oil gives about the same inhibitory value as chaulmoogra, in spite of the fact that it contains largely chaulmoogric acid and very little, if any, hydnocarpic acid, according to investigations of Brill.[6]

In order to ascertain whether the inhibition of growth, as detected in earlier experiments,[7] when certain vegetable oils were brought in direct contact with the freshly inoculated culture, is due to their volatile constituents, to volatile secondary products evolved during drying of the oil, or to the stable constituents of the oil, experiments were arranged to permit study of the growth of acid-fast bacilli in the atmosphere of the vapors given off, without the substance under test coming in direct contact with either the growing culture or the medium on which it was planted.[8]

A comparison of the results of these two parallel tests carried out with the same oils gives an explanation of the nature and mechanism of their inhibition of growth in vitro.

[5] Philip. Journ. Sci. 23 (1923) 533.

[6] A chemical investigation of the seeds of Pangium edule and Hydnocarpus alcalæ, Philip. Journ. Sci. § A 12 (1917) 37.

[7] Philip. Journ. Sci. 24 (1924) 23.

[8] Philip. Journ. Sci. 23 (1923) 533–542; 24 (1924) 23–27 and 443–445.

It is evident from Table 1 that the nature of the inhibition of growth produced by the essential oils is different from that caused by chaulmoogra oil and hydnocarpus oil, in as much as the essential oils inhibit the growth of acid-fast bacilli by their volatile constituents, which is not the case with chaulmoogra and hydnocarpus oils. Nevertheless, it is interesting to note that the volatile oils do inhibit *Bacillus tuberculosis* and that this inhibition, in some cases at least, shows a strong indication of being selective toward the acid-fast bacilli. Further information as to the activity of the constituents of the essential oils has been obtained by experiments already published.[9] Since cedar oil inhibits the growth of *B. tuberculosis* perceptibly by its volatile constituents, although not completely, there remain out of our collection practically only two oils, besides the chaulmoogra and hydnocarpus, which under the arrangement of tests adopted in this experiment behaved similarly to the oils containing the peculiar acids from the chaulmoogric series.

As these oils, palomaria and cashew, are known not to contain the acids from the chaulmoogra series, we must look to other nonvolatile constituents for explanation. In the case of palomaria, the resin separated from the oil inhibited the growth of *B. tuberculosis* when brought into direct contact with a freshly inoculated culture, and it is most likely responsible for the activity of the crude oil.

The cashew oil obtained from the kernel of the seed is, according to Watt,[10] equal to almond oil in its quality but, according to the same author, a yellowish acrid and highly caustic oil is obtained from the shell of the seed and is said to be useful for preservation of wood, books, etc., against white ants. This substance, cardole, mixed with the cashew oil, very likely is responsible for the inhibition of growth that occurred in our test.

It was quite natural to look to the chemistry of chaulmoogra oil for the explanation of its specific curative value in leprosy and of its selective growth-inhibiting action upon acid-fast bacilli.

Two chemical properties, particularly, of chaulmoogra oil were considered as probably explanatory of its therapeutic

[9] Philip. Journ. Sci. 23 (1923) 533–542; 24 (1924) 23–27 and 443–445.

[10] See West, A. P., and Brown, W. H., Philippine Resins, Gums, Seed Oils, and Essential Oils, P. I. Bureau of Forestry Bull. No. 22, 2 (1921) 146.

effect in the treatment of leprosy; namely, the degree of unsaturation and the chemical structure of the fatty acids, the latter differing radically from the structure of the fatty acids obtained from any other known vegetable oil.

As far as the growth-inhibiting effect of vegetable oils in general is concerned, the degree of unsaturation in itself can be disregarded as the cause of the selective antiseptic action, as will be seen from results of experiments shown in Table 2.

In Table 2 nonvolatile oils are tabulated, as far as they have been tested by us; their degree of unsaturation, as indicated by the iodine number (from Lewkowitsch[11]), is given in one column, and their growth-inhibiting titer and value are given in columns 3 and 4.

In analyzing the results, with the view to detect whether or not there is any relation between the degree of unsaturation and the inhibitive action of the particular oil, one can see that linseed, maize, kapok, cod-liver, shark-liver, and sesame oils show a higher degree of unsaturation (iodine number higher than 104) than chaulmoogra, but their growth-inhibiting value is equal to zero; while chaulmoogra, with a growth-inhibiting value of 20 and more has the iodine number 90.7 to 104. The member of our collection having the highest degree of unsaturation, linseed oil (iodine number 173 to 201), gives a growth-inhibiting value equal to zero, whereas coconut oil, having the lowest iodine number (8 to 10) has a growth-inhibiting value of 1.

The second highest unsaturated oil, bagilumbang (iodine number 158.5 to 166), has a value of 1, while lumbang, with about the same iodine number in 1 per cent concentration, stimulates the growth of *Bacillus tuberculosis* rather than inhibits it.

Gynocardia odorata oil, which is obtained from a plant closely related to those that yield chaulmoogra, is biologically inactive in spite of the fact that its degree of unsaturation is higher (iodine number 152.8) than chaulmoogra, which has a very marked growth-inhibiting effect.

The quantitative differences in the degree of unsaturation are rather slight, it is admitted, with those oils that contain the optically active fatty acids; but, even so, we find that *Hydnocarpus wightiana* oil, which inhibits the growth to the highest dilution

[11] Chemical Technology and Analysis of Oils, Fats, and Waxes, ed. 6 (1921).

used with all the related oils tested, has not the highest iodine number.

There being sufficient experimental evidence to the contrary, the theory which would explain the selective growth-inhibiting effect in vitro with regard to the acid-fast bacilli by the unsaturation of oils alone becomes untenable; there remains the peculiar structure of the acids of the chaulmoogric group as the only explanation, particularly when the possibility has been eliminated that constituents other than the fatty acids are the active principle.

Walker [12] suggested, as an explanation of the chemical process responsible for the antiseptic effect of chaulmoogra oil, Ehrlich's side-chain theory. He says:

> Fat elaborating bacilli attempt to utilize the chaulmoogric acids to build up their fatty capsules, and these cyclic fatty acids contain a group or an arrangement of atoms which is toxic for the bacterial cell. In the terminology of Ehrlich's side chain theory, we may express this reaction by saying that chaulmoogric acids possess a haptophore group which becomes attached to the receptor or side chain of the acid fast bacillus, and a toxophore group which, after attachment, exerts a toxic action on the bacillus.

With this hypothesis in mind one is tempted to assume that vegetable oils, so far as their bacteriotropic action is concerned, have a haptophoric group (which is their condition of unsaturation) and a group of specific inhibition (which is their chemical structure), in other words, their toxophore group; while other oils have their haptophore group (unsaturation) and their nutriphore group or, in the words of Walker, a group or an arrangement of atoms which is stimulating to the growth of the bacterial cell. If this be true, the removal of the haptophore function (that is, the complete saturation by a biologically inert substance) should deprive the oil of its growth-inhibiting or growth-stimulating power, as the case may be, unless these properties of the oil are due to some other substance than the fatty acids present in the particular oil.

Table 3 gives the results of parallel tests of a sample of chaulmoogra oil compared with the same chaulmoogra oil after it has been partially and completely saturated with iodine. The partially saturated chaulmoogra oil was prepared by adding iodine in solution until it retained the dark color, while the completely saturated sample of the oil was prepared by the

[12] Walker, E. L., and Sweeney, M. A., Journ. Inf. Dis. 1 (1920) 1.

Hanus method. The test included a sodium soap of the total fatty acids of chaulmoogra oil partially saturated with iodine and the same soap in its original condition.

The results would indicate that partial saturation with iodine neither decreases nor increases the growth-inhibiting power of chaulmoogra oil, whereas complete saturation deprives the oil of its growth-inhibiting activity. In view of the fact that chaulmoogra saturated with iodine is being used in leprosy therapy, these findings are of interest. From the theoretical standpoint, however, the objection must be raised that, through the saturation of the oil by iodine, a new element has been introduced into the composition of the fatty acids and we are, therefore, dealing with a different chemical compound, so that the conclusions drawn from its biological behavior cannot be applied to the original compound. Furthermore, the completely saturated chaulmoogra oil was a very heavy viscous oil, the even emulsification of which in agar was very difficult and incomplete.

It was necessary, therefore, to arrange experiments with hydrogenized oil; that is, chaulmoogra oil saturated with hydrogen, which is an element already present in the fatty acids of this oil.

Through the courtesy of Dr. A. P. West, professor of chemistry, University of the Philippines, who supplied me with hydrogenized lumbang, pili-nut, and chaulmoogra oils, I was enabled to carry out these experiments.

The results of this test prove experimentally the correctness of my supposition, at least so far as chaulmoogric acids are concerned. It can be seen from Table 3 that the original sample of chaulmoogra oil which was used for hydrogenization equaled the previously tested sample of "chaulmoogra, Japan" (see Table 1) in its growth-inhibiting activity. After five hours' hydrogenization the chaulmoogra oil still showed inhibition in 1 per cent and 0.5 per cent concentrations, while the sample hydrogenized for twenty hours gave only slight inhibition in 1 per cent concentration in agar; that is to say, a value of less than 1 as compared with the value 20 of the original sample.

With the hydrogenized pili-nut and lumbang oils, which were originally found to stimulate the growth of *Bacillus tuberculosis,* the results were not so striking as they were in the case of chaulmoogra oil, because the medium (glycerine meat broth agar) in which the oil was suspended is in itself sufficient for the growth of *B. tuberculosis.* Nevertheless, in the culture

tube to which pili-nut oil was added the growth was perceptibly more luxuriant at the end of one week of incubation than in the control tubes, while the culture tubes containing 1 per cent of hydrogenized pili-nut oil showed the same growth as the control tubes. The culture tubes containing fresh lumbang oil grew slightly better than did those containing hydrogenized lumbang oil, in which the growth was equal to that in the control culture tubes.

It had been noticed during the survey of vegetable oils [13] as to their growth-inhibiting action that certain oils added to glycerine meat infusion agar stimulate the growth of *Bacillus tuberculosis.* The objection may be raised that the judging of the difference of growth in the various culture tubes is subject to the personal equation. A more convincing and at the same time technically easy method was sought and, after several preliminary attempts, the following method was found to answer the purpose:

If the vegetable oils enter into the metabolism as food, which enables them to multiply, it was argued that the addition of such oils as were found noninhibitory might enable the acid-fast bacilli to grow on culture media on which they usually do not grow. Plain meat extract +1 acid agar was chosen, therefore, as a medium to which the oils mentioned above were added, and the mixture thoroughly shaken and quickly solidified in a slanted position. Plain meat extract +1 acid agar slants were taken as negative controls, while glycerine meat infusion +1 acid agar slants were simultaneously inoculated to see that the seed culture contained *Bacillus tuberculosis,* viable under favorable conditions. The results of these experiments are evident from Table 4. They show that certain vegetable oils or their components are taken up as food by acid-fast bacilli.

It is reasonable to believe that, in the process of assimilation, the bacteria themselves do not remain inactive. Evidence [14] is on hand that soluble lipase is formed in growing cultures of acid-fast bacteria. Vegetable oils are polyglycerides or glyceryl esters of higher and lower fatty acids. It remains therefore to find out whether the fatty acids themselves or the glyceryl part of the oils, or both, are taken up by the acid-fast

[13] Philip. Journ. Sci. 24 (1924) 23.

[14] Kendall, A. I., Walker, A. W., and Day, A. A., Journ. Inf. Dis. 15 (1914) 443.

bacteria. It is a well-known fact that glycerol stimulates the growth of acid-fast bacteria in artificial culture media.

In order to decide this question fatty acids of those oils which proved to supply sufficient food to acid-fast bacteria to enable them to grow on unfavorable culture media were added to plain meat extract +1 acid agar and the culture tubes were inoculated with a young culture of *Bacillus tuberculosis* after thorough shaking and rapid cooling. High alcohols, as far as available, were included to see how far these chemicals are concerned in the metabolism of acid-fast bacteria. The results of these tests are tabulated in Table 5; they prove that the growth-stimulating power of certain vegetable oils is due to the glyceryl part of the oils, and not to the fatty acids which they contain.

The results of these experiments are very instructive, in as much as they show that the unsaturation of oils containing the specific fatty acids which have selective inhibiting effect in vitro on the growth of acid-fast bacteria is paramount. Complete saturation of the fatty acids by hydrogen rendered chaulmoogra oil biologically inert. The saturation of the acids from the chaulmoogra series, however, takes place on the hydrocarbon ring and produces changes in the structure of the ring itself (there is loss of optical rotation after hydrogenization). Therefore, the specific growth-inhibiting activity of the acids from the chaulmoogric series is bound to the structure of the hydrocarbon ring. The length of the side chain may influence the growth-inhibiting activity of the individual acids from the chaulmoogric series; but, if conclusions arrived at from the investigation of open-chain acids apply equally well to side chains of hydrocarbon rings, the length of the side chain (that is, the number of CH_2 groups) should decrease rather than increase it. Furthermore, the length of the side chain may affect the solubility of the compound. It was noticed that the sodium salt of chaulmoogric acid ($C_{18}H_{32}O_2$) gave a lower value than the sodium salt of the hydnocarpic acid ($C_{16}H_{28}O_2$). The investigation as to the growth-inhibiting effect of open-chain organic acids shows that, with the increase in number of CH_2 groups, the growth-inhibiting activity of the individual acids, tested in the form of slightly alkaline soap, decreases gradually, if not regularly, from formic acid down. One member of our collection, however, the cinnamic acid, possessing a double bond, stands out as the one giving the highest growth-inhibiting value of all the acids tested. This finding suggests

a similarity between the double-bonded structure of this acid and the structure of the hydrocarbon ring of the chaulmoogric acids.

Cinnamic acid (C_6H_5 CH=CH COOH) has a double bond, linking a carboxyl group on one side with a phenyl group on the other side by CH=CH. In the terms of the theory, the double-bonded group acts as a haptophore and the phenyl group as a toxophore group. The substitution of an H in the phenyl group by OH in oxycinnamic or cumaric acid lowers the growth-inhibiting activity from 100 to less than 1, although the haptophore group (CH=CH) is present in cumaric as well as in cinnamic acid. On the other hand, the phenyl group (that is, the toxophore group) is represented in benzoic (C_6H_5 COOH) as well as in mandelic acids (C_6H_5 CH (OH) COOH), both of which nevertheless give a low growth-inhibiting value (about 1).

Similar conditions prevail in allyl alcohol and cinnamyl alcohol. Allyl alcohol (CH_2=CH CH_2 OH) is an unsaturated alcohol giving a growth-inhibiting value of 2. The introduction of the phenyl group in place of one H in CH_2, cinnamyl alcohol (C_6H_5 CH=CH CH_2 OH), raises the growth-inhibiting value from 2 to 20.

On the other hand, crotonic acid (CH_3 CH=CH COOH) has the same haptophore group (CH=CH), but the phenyl group is replaced by the methyl group which is responsible for the comparatively low growth-inhibiting value (less than 2).

Considering the great similarity in chemical structure of certain cyclic compounds, one can see that the double bond on the ring is present in the ineffective carvene as well as in the strongly effective carvone. On the other hand, the CO group, which makes the only difference between the carvene ring and the carvone ring, is present in pulegone also, but the latter lacks the double bond on the ring. We have to a certain extent in carvene, pulegone, and carvone a case analogous with that in oxycinnamic, benzoic, and cinnamic acids with regard to their structure and antiseptic effect.

These compounds (carvene, carvone, and pulegone) stand to each other with regard to their antiseptic activity as they do with regard to their physiological effect on the central nervous system and the motor-nerve terminals. According to L. Spiegel,[15]

[15] Chemical Constitution and Physiological Action, translated by C. Luedeking and Boylston (1915) 73 and 74.

> The behavior of Thujone is similar to Camphor, but * * * Carvone is a poison which has a violent cramp producing action, which may perhaps be attributed to the double bond in the ring. A reason for ascribing this action to the double bond is that such an effect does not occur * * * for Pulegone,

which lacks the double bond in the ring.

The oils that stimulate the growth of acid-fast bacteria or, in other words, are taken up as food by the bacteria, behave similarly with regard to the relation between the unsaturation and their growth-stimulating activity as do those which inhibit the growth. Pili-nut oil, for example (iodine number 61.25) stimulates the growth of *Bacillus tuberculosis* to the same extent as does olive oil (iodine number 79 to 88), that is to say, much more than lumbang oil which is more highly unsaturated (iodine number 114 to 163) than either of the two other oils; but completely saturated lumbang, like pili-nut oil, has lost its growth-stimulating activity. Consequently, the degree of unsaturation is not the deciding factor, although the condition of unsaturation is essential. It appears that the oils must be unsaturated in order to enter into the metabolism of the bacteria, but it depends on the chemical structure whether or not the product of assimilation of the oils by the bacteria will be deleterious to the latter. The growth-stimulating effect is due to the glycerine part of the oil since, as has been already mentioned, the fatty acids separated from growth-stimulating oils proved to be without effect. (See Table 5.)

A phenomenon observed by Walker and Sweeney [16] in their tests of chaulmoogric preparations, that certain irregularities occurred in dilutions approaching the border line of inhibition, is of interest. Similar observations were made in my experiments where solid media were used. I noticed at times that single or few isolated colonies developed in culture tubes containing dilutions of chaulmoogric preparations which usually gave complete inhibition. These colonies did not spread widely over the surface of the culture medium as is customary with acid-fast bacilli, but their growth piled up vertically forming in due time cupolated moist colonies. Similar growth was observed on highly acid glycerine agar on the occasion of testing the reaction range of our particular strain, while toward the

[16] The chemotherapeutics of the chaulmoogric acid series and other fatty acids in leprosy and tuberculosis, Journ. Inf. Dis. 1 (1920) 1.

alkaline end of the scale of culture media the growth developed dry, spreading, and corrugated.

It occurred to me, naturally, that these isolated atypical colonies may represent what might be termed adaptation mutants, and I proceeded to transplant them on glycerine agar slants; some of the slants contained the same concentration of chaulmoogric preparations as the ones on which the so-called mutants occurred, others contained a lower concentration, and still others a higher concentration. The growth was slow in developing, so that transplants were made once or twice a month. The subculture which showed growth on the highest concentration was further transferred to glycerine beef agar containing the same amount of chaulmoogric salt, as well as to media containing a lower and a higher concentration thereof.

After eighteen months of a forced adaptation process the strain showed a tolerance to sodium gynocardate ten times higher than originally.

This observation seems to be of interest, since a similar phenomenon has been observed by others, using various nonacid-fast bacteria and chemicals like arsenic compounds and aniline dyes, which substances enter into direct chemical combination with bacterial substances. May not this phenomenon explain, in part at least, the clinical experience that leprosy in patients receiving chaulmoogra treatment after initial improvement becomes stationary?

The following abbreviations are used in Tables 1, 3, 4, and 5:

+, growth as good as control.
—, no growth.
+inh, growth scanty, compared with control.

CONCLUSIONS

1. The degree of unsaturation of vegetable oils which stimulate the growth of acid-fast bacteria and of those which inhibit the growth of acid-fast bacteria has no relation to their growth-stimulating or growth-inhibiting activity.

2. The growth-stimulating effect of certain vegetable oils is due to the glyceryl and not to the acid part of the oil.

3. The condition of unsaturation of the oils containing the acids from the chaulmoogra series and of the oils which stimulate the growth of acid-fast bacteria is paramount.

4. Saturated chaulmoogra oil lacks the growth-inhibiting activity toward acid-fast bacteria which is possessed by the unsaturated oil.

5. The growth-inhibiting activity of chaulmoogra oil depends on the structure of the ring of the fatty acids. When the structure of the ring is changed by saturation with hydrogen the oil loses this biologic property.

6. There are indications that, due to physical properties, acids from the chaulmoogric series containing a short side chain are more effective in vitro than are those having a long side chain.

7. Acid-fast bacteria adapt themselves to the acids from the chaulmoogric series in due time and then withstand larger doses than they did originally.

TABLE 1.—*Showing the different nature of the growth-inhibiting action of chaulmoogra and volatile oils.*

Name of oil.	Growth-inhibiting effect by direct contact with *Bacillus tuberculosis.*	Growth-inhibiting effect of vapors upon *Bacillus tuberculosis.*
Chaulmoogra, India	—	+
Chaulmoogra, Japan	—	+
Hydnocarpus wightiana	—	+
Hydnocarpus alcalæ	—	+
Hydnocarpus venenata	—	+
Hydnocarpus subfalcata	—	+
Gynocardia odorata	+	+
Bergamot	—	—
Cashew	—	+
Caryophyllum	—	—
Cedar	—	+inh
Cinnamon	—	—
Citrus microcarpus	—	—
Dacrydium	—	—
Eucalyptol	—	—
Palomaria	—	—
Palomaria resin	—	+
Pinus sylvestris	—	+
Vetiver	—	+inh

TABLE 2.—*Showing the relation between the degree of unsaturation and the growth-inhibiting action of vegetable oils.*

Name of oil.	Iodine number (Lewkowitsch).	Growth-inhibiting titer.	Growth-inhibiting value.
Linseed	173–201	0	0
Cedar	159.2	0.1	1
Gynocardiæ odoratæ	152.8	0	0
Maize	111–120	0	0
Kapok	116–117.9	0	0
Sesame	103–108	0	0
Olive	79–88	0	0
Castor	83–90	0	0
Cod liver	154.5–181.3	0	0
Chaulmoogra	90.7–104	0.005	20
Margosa	69.6	0	0
Palm	51.5–57	0	0
Coconut	8–10	0.1	1
Peanut	92–100.8	0.1	1
Pili-nut	61.25	0	0
Lumbang	114.2–163.7	0	0
Bagilumbang	158.5–166	0.1	1
Cashew	84	0.01	10
Shark liver	114.6	0	0

TABLE 3.—*Showing the results of growth-inhibiting tests with saturated and unsaturated chaulmoogra oil and its derivatives.*

Medium used, glycerine agar, to which was added 0.1 cubic centimeter of—	Growth in four weeks.	Value.
Chaulmoogra oil, original	—	20
Chaulmoogra oil, hydrogenated 5 hours	+	2
Chaulmoogra oil, hydrogenated 20 hours	+	< 1
Chaulmoogra oil, iodine partially saturated	—	20
Chaulmoogra oil, iodine completely saturated by Hanus method	+	< 1
Gynocardate A 3 per cent, original	—	20
Gynocardate, iodine partially saturated	—	20

TABLE 4.—*Showing the growth-stimulating effect of certain vegetable oils and alcohols.*

Name of oil added to plain meat extract +1 acid agar.	Amount added to 10 cubic centimeters of plain agar.	Growth of *Bacillus tuberculosis*.	
		Two weeks.	Four weeks.
	cc.		
Avocado	0.1	—	—
Bayavac	0.1	—	—
Betis	0.1	—	—
Calamis	0.1	+	+
Castor	0.1	+	+
Coconut	0.1	—	—
Camachili	0.1	—	—
Kalumpang	0.1	+	+
Kapok	0.1	—	—
Linseed	0.1	—	—
Lumbang	0.1	+	+
Lumbang, hydrogenized	0.1	—	—
Maize	0.1	+	+
Olive	0.1	+	+
Palomaria	0.1	—	—
Peanut	0.1	—	—
Petroleum nut	0.1	—	—
Pili-nut	0.1	+	+
Pili-nut, hydrogenized	0.1	—	—
Sesamum	0.1	—	—
Shark liver	0.1	—	—
Sincamas	0.1	—	—
Gynocardia odorata	0.1	—	—
Glycerine agar, control	0.5	+	+
Plain agar, control	2	—	—

TABLE 5.—*Showing the results of growth-stimulating tests with alcohols and organic acids, including acids separated from vegetable oils which stimulate the growth of acid-fast bacilli.*

Name of alcohol or acid.	Amount added to 10 cubic centimeters of plain agar.	Growth after four weeks incubation.
	cc.	
Heptyl alcohol	0.1	—
Octyl alcohol, normal	0.1	—
Octyl alcohol, secondary	0.1	—
Melissyl alcohol	0.1	—
Cetyl alcohol	0.1	—
Piperonyl alcohol	0.1	—
Oleic acid	0.1	—
Oxalic acid	0.1	—
Succinic acid	0.1	—
Citric acid	0.1	—
Hydrocinnamic acid	0.1	—
Cumaric acid	0.1	—
Terephthalic acid	0.1	—
Uric acid	0.1	—
Camphoric acid	0.1	—
Total fatty acids of castor oil	0.1	—
Total fatty acids of olive oil	0.1	—
Total fatty acids of lumbang oil	0.1	—

DETECTION OF TRACES OF ALKALI OR SOAP IN REFINED COCONUT OIL

By WALTER L. BROOKE
Chemist, Bureau of Science, Manila

In the manufacture of oleomargarine from refined coconut oil, considerable difficulty was experienced because the butter substitute, a short time after manufacture, developed a sharp soapy taste. In attempting to locate the cause of this trouble, it was thought that perhaps the small amount of sodium carbonate in the caustic soda that was used to refine the crude oil failed to combine with the free fatty acids or failed to saponify the esters in the time and at the temperature at which the refining was performed. A slight excess of caustic solution was always used over and above that actually needed to neutralize the free fatty acids which a control analysis showed to be present.

Sodium carbonate was thought to be the cause of the soapy taste because—

1. After neutralization in refining, the oil was held at high vacuum for a considerable time, so that the soap would become anhydrous and be precipitated from the dry oil.

2. The soapy taste in the butter only developed several days or a week after the butter had been made.

3. A comparative saponification experiment with sodium hydroxide and sodium carbonate indicated that with sodium carbonate the rate of saponification of coçonut oil is much less than with sodium hydroxide.

In view of the facts, it became important that a laboratory method of detecting small amounts of carbonate or alkali in the refined oil be available. The only methods with which I was familiar were those of Marcusson [1] and of Siepel,[2] both of which are based on the insolubility of soap in acetone. Siepel states that the best way to detect soap in oils is by ashing.

[1] Eighth Int. Congr. of Applied Chem. **25** (1912) 777.
[2] Seifensieder Ztg. **40**: 199.

It was decided to run a few ignition experiments to determine the sensitivity of this ashing method of detecting soap or alkali in oils. The oil used was a refined coconut oil which was washed three times with hot distilled water to make sure that it contained no soap or alkali. Twenty-five grams of the oil were weighed in a nickel crucible and then varying amounts of sodium carbonate were added, the oil burned, first, by keeping the flame of a Bunsen burner in contact with its surface and, later, by putting it in a Muffle furnace and bringing it to a red heat. If the oil was heated with a flame until it burned without a Bunsen burner as a pilot light, great quantities of soot would be produced. The development of a pink color upon the addition of a few cubic centimeters of distilled water and a drop of phenolphthalein was considered sufficient evidence of the presence of alkali or soap in the oil. Anhydrous chemically pure sodium carbonate was used in these experiments. The results are shown in Table 1.

TABLE 1.

Experiment	1	2	3	4	5
Oil grams	25.0	25.0	25.0	25.0	25.0
Sodium carbonate do	0.0	0.0118	0.0090	0.0052	0.0046
Reaction to phenolphthalein	----------	Pink.	Pink.	Pink.	Pink.
Sodium carbonate per cent	0.0	0.047	0.036	0.0208	0.0184

Because the error introduced in weighing such small amounts of substance would be considerable, it was decided to use a solution. An aqueous solution could not be used as it caused sputtering in the burning of the oil. Sodium ethylate (made by dissolving solid sodium hydroxide in absolute alcohol) proved to be the most convenient way of introducing the alkali. The strength of the ethylate was determined by titration against a standard acid solution. The experimental results are recorded in Table 2.

TABLE 2.

Experiment	1	2	3
Oil grams	25.0	25.0	25.0
Ethylate cc	5.0	2.0	1.0
Equivalent sodium hydroxide grams	0.0014	0.00057	0.00028
Phenolphthalein reaction	Pink.	Pink.	Pink.
Sodium hydroxide per cent	0.005	0.0023	0.0011

A more dilute solution of alcoholate was now made by diluting some of the former ethylate solution with absolute alcohol (see Table 3).

TABLE 3.

Experiment	1	2	3
Oil, grams	25.0	25.0	25.0
Ethylate, cc	1.0	0.75	0.5
Sodium hydroxide, grams	0.000162	0.000121	0.000081
Reaction to phenolphthalein	Pink.	Pink.	Pale pink.
Sodium hydroxide, per cent	0.00065	0.00048	0.00033

All of these experiments were done in duplicate and the results agreed in all cases. In the tests recorded in Table 3, the phenolphthalein color began to be lighter than in those recorded in Table 1. In experiment 3 it was still visible, although much lighter than the color of experiment 1.

In these experiments a nickel crucible was found to be better than a porcelain one, because the temperature that was required to decolorize the charred residue was sufficient partly to fuse the glazed surface on the porcelain crucible. The removal of the last traces of alkali from such a partly fused surface is very difficult.

CONCLUSIONS

1. Less than 0.02 per cent sodium carbonate can be detected in 25 grams of coconut oil by ashing and testing with phenolphthalein.

2. As small an amount as 0.00065 per cent sodium hydroxide can be detected in 25 grams of coconut oil with certainty by ashing.

3. A nickel crucible is preferable to a porcelain crucible for ashing.

A TOOTH OF A FOSSIL SHARK FROM TAMBARON ISLAND, NEAR SOUTHERN MINDORO

By A. N. KRYSHTAFOVICH

Of the Geological Survey of Russia, Vladivostok

ONE PLATE

Carcharodon arnoldi Jordan. Plate 1.

Carcharodon sp., MURRAY, Rep. Challenger Exped., Deep Sea Deposits (1891) 269, pl. 5, figs. 3 and 4.

Carcharodon megalodon ISHIWARA.[1]

Carcharodon arnoldi JORDAN, Univ. Cal. Publ., Bull. Dept. Geol. 5 (1907) 113, fig. 13; JORDAN and BEAL, Univ. Cal. Publ., Bull. Dept. Geol. 7 (1913) 252; ISHIWARA, Sci. Rep. Tohoku Imp. Univ. II Geology, No. 3, 5 (1920) 67 (7), pl. 12 (III), figs. 3, 4.

Locality, western coast of the southern point of Tambaron Island, southern Mindoro, in Bulalacao Bay; probable Vigo group.

The tooth under consideration was found by Mr. G. B. Moody in the conglomerate dipping at a moderate angle to the southwest. The length of the tooth is 6.2+ centimeters and the width at the base, 5.6+ centimeters; the maximum thickness of the crown, 1 centimeter. The edges of the crown are, as usual, minutely serrated, about 60 serræ on each side.

Carcharodon arnoldi differs from *C. megalodon* by the less numerous, coarser, and more acutely pointed serræ than in *C. megalodon*, but they are more numerous, finer, and blunter than in existing *C. carcharias;* similar teeth, described from Japan, possess about 65 or more serræ on each side of the crown (preserved specimens have only 50 to 52).

The shape of this tooth is flatly and acutely conical, less broad at the base than usual for *Carcharodon megalodon.* The inner surface is moderately convex; the outer, slightly convex. Ishiwara is of opinion that *C. arnoldi* is really an extinct species, intermediary between extinct *C. megalodon* and the still existing *C. carcharias* (Linn.). This opinion is opposed to the view of Leriche, who pointed out that *C. arnoldi* and *C. riversi* are identical with the living *C. carcharias.* However, Jordan and Beal are not inclined to adhere to Leriche's opinion. Ishiwara thinks

[1] Date and place of publication not known.

that, though *C. riversi* is overlapped by the characters of existing *C. carcharias*, the tooth of *C. arnoldi* represents apparently a separate species, because the largest teeth of *C. carcharodon* possess only 46 to 48 serræ, while the serræ of *C. arnoldi* number 60 and more (*C. megalodon* has over 100 serræ).

Carcharodon arnoldi has been found hitherto in the following localities:

South Pacific Ocean at a depth of 2,385 fathoms, by Challenger Expedition.
Burma, Pegu shales, at Padaukpin (sub *C. megalodon*).
California, in Pliocene and Quaternary strata.
Japan, at Shimoda, Idzu Province, and at Iruma, Sagami Province.

To this list we now add Tambaron Island, in Bulalacao Bay, southern Mindoro, Philippine Islands, probably in the deposits of Vigo group (Lower Miocene?).

The larger and more abundantly serrated teeth of *Carcharodon megalodon* have been found in numerous localities of Europe and America, in the strata since Eocene to Pliocene age, as well as in the following several localities of Japan:

Miocene (?):
- Nagakubo, Mutsu Province.
- Yumachi, Idzumo.
- Ashiarai and Otsu, Hitachi Province.
- Togari, Mino Province.

Neogene:
- Dzushi, Uraga, Yokosuka, Sagami Province.
- Nokogiri, Akasaki, Awa Province.
- Mito, Hitachi Province.
- Shimojo, Usuda, Shinano Province.
- Nagasaki, Mino Province.
- Hiuchidani, Hannoura, Noto Province.
- Torawa, Ugo Province.
- Kachimadai, Kanagase and environs of Sendai, Rikuzen Province.

Hokkaido:
- Hatsune mines, Futorogori, Shiribeshi Province.
- Meppu mines, Setunai gori, Shiribeshi Province.

ILLUSTRATION

PLATE 1. *Carcharodon arnoldi* Jordan; from photographs of a tooth collected on Tambaron Island, Bulalacao Bay, Mindoro.

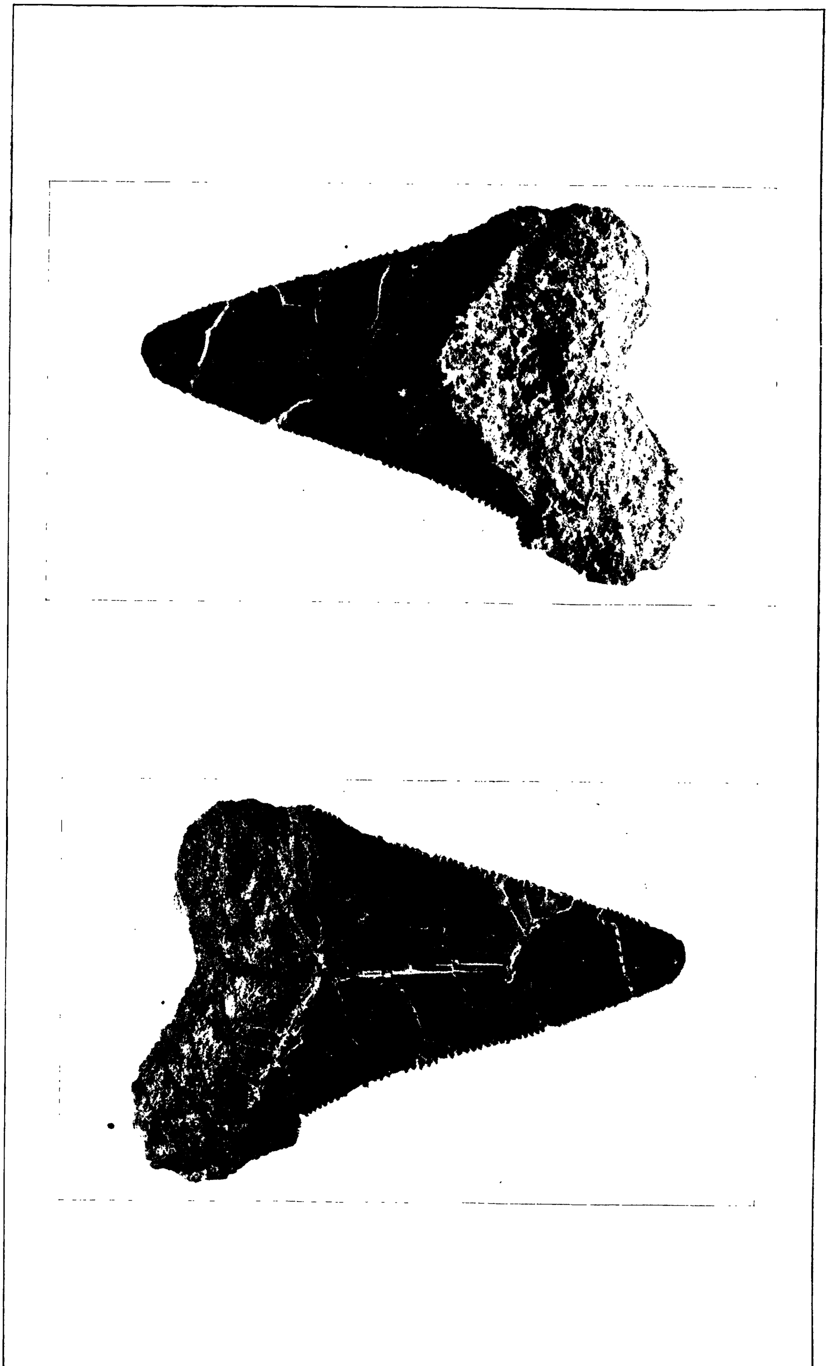


PLATE 1. A TOOTH OF CARCHARODON ARNOLDI JORDAN.

CLASSIFICATION OF THE PHILIPPINE COMPONENTS OF THE COLEOPTEROUS FAMILY CLERIDÆ

By EDWARD A. CHAPIN

Of the United States Department of Agriculture, Washington, D. C.

FIVE PLATES

When we review the great questions arising out of the geographical distribution of animals and plants, there can be no doubt whatsoever that the close investigation of any given area, however minute, must contribute materially, provided its position be a significant one, to lighten the labours of those more comprehensive naturalists who are able to wield, with a master's hand, the scanty data gleaned by the humbler workers in the science, to a practical account. And, since it has been said that whatsoever falls within the sphere of knowledge is attached to a radius and tends towards the centre, there is reason to hope that no amount of truth, once fairly arrived at, will be eventually lost; but that it will sooner or later find its way into the central mass, to be employed, whensoever chance may require it, for the general good. Hence it is that we are encouraged, in every branch of observation, to register what we see; and to feel that the most trivial facts, if faithfully recorded, may become the basis from whence the soundest theories may arise—such theories forsooth as have already arisen from the contemplation of circumstances apparently beneath our notice, and which have grown up, step by step, into trees of gigantic dimensions, to embrace at last large principles within their shade.—*T. Vernon Wollaston.*

HISTORICAL

Until Prof. C. F. Baker commenced his work in the Philippines, there had been no systematic collecting on a large scale of the insect fauna, with the result that there have been, up to the present, very few species of Cleridæ described from that Archipelago. *Thaneroclerus buqueti* (Lef.), 1835, an insect of considerable economic importance to the tobacco industry, appears to be the first species to be made known from the Islands. Between 1835 and 1876 Chevrolat described two species, one of which was made the type of the genus *Cladiscus;* the other, *Tenerus philippinarum,* if the measurements given in the description are correct, will prove to be a most aberrant species of its genus. In 1876 Gorham started a series of papers on the Cleridæ of the world. The first of the series appeared in Cistula Entomologica. The remaining three papers were published

in the Transactions of the Entomological Society of London for 1877 and 1878. In this series Gorham lists twenty-three species of Cleridæ which were collected, mainly on Mindanao and Luzon, by Semper. Of these, seventeen are described as new. During the same year Waterhouse erected the genus *Sisyrnophorus* to contain *maculatus,* a new species. Since then this genus has been suppressed in favor of *Allochotes* Westw. Between 1878 and the present only a few species have been added to the Philippine list. Two species were made known by Schenkling in 1913, eleven by Chapin in 1919 and 1922, and six by Heller in 1921.

ZOÖGEOGRAPHY

The zoögeographic provinces of the Philippine Islands have been worked out, from the standpoint of the avifauna, by McGregor. While at present nothing is known of the clerid fauna of many of the islands, and very little of others, still it is interesting to note that in general the distribution of the Cleridæ by faunal regions coincides to a very pleasing degree with McGregor's findings. For instance, the two known species from Palawan have marked Bornean affinities, *Callimerus fenestratus* Chpn. is close to *C. bellus* Gorh., and *Dasyceroclerus banksi* Schklg. is not only closely related to *D. cylindricus* (Westw.) but is also the only representative of the genus known from the Philippines. There is only one point in which the results of this study conflict with McGregor's; Basilan is apparently not sharply separated from Mindanao in regard to fauna; at least, the differences between Palawan and Mindanao are much greater than between Basilan and Mindanao. If Palawan and Mindanao are accepted as divisions of equal rank, Basilan should be designated as a subdivision of Mindanao.

SCHEME OF CLASSIFICATION

The system adopted in this work is essentially that of Schenkling (1903), in that the six subfamilies outlined by him are, with some modifications, put into use. The classification of the family into two subfamilies and six tribes, which was developed by Lacordaire and utilized more or less continuously since his time, is not followed, because a study of the species of the world shows too many instances where it is impossible to classify the insect according to this system without violating its

natural affinities. By the erection of one new subfamily which combines characters supposed to pertain to the first subfamily of Lacordaire with characters of fundamental importance in the second, and by the elevation of Lacordaire's tribes to subfamily rank, it is believed that a more logical and natural system, so far as our present knowledge is concerned, is produced.

Although the subfamilies used in this work correspond practically to the tribes of Schenkling (1910) the characters used to separate them are in part different, resulting in some interchange of genera. For instance, instead of placing in the Tillinæ all species whose tarsi are composed of five well-developed segments, regardless of their other characters, the structure of the thorax is considered. *Callimerus* Gorh. in every character except its tarsi is hydnocerine; in the present system it finds its place there without difficulty. *Thaneroclerus* Lef. is withdrawn from the Clerinæ and becomes the type of a new subfamily, the Thaneroclerinæ. Other genera remain as they were assigned by Schenkling. The subfamilies themselves are arranged in a slightly different order to conform to my views regarding their relations.

TILLINÆ

Genus CYLIDRUS Latreille

1. *cyaneus* (Fabr.).

Genus CLADISCUS Chevrolat

2. *bacillus* Heller.
3. *bakeri* sp. nov.
4. *bicolor* sp. nov.
5. *clypealis* sp. nov.
6. *mindanensis* sp. nov.
7. *strangulatus* Chevr.
8. *vicinus* sp. nov.

Genus DIPLOPHERUSA Heller

9. *tumidipes* Heller.

Genus CYLIDROCTENUS Kraatz

10. *chalybeus* (Westw.).

Genus TILLUS Olivier

11. *bifasciellus* White.
12. *carinatulus* Schklg.
13. *mindanensis* Chpn.
14. *notatus* Klug.

Genus GASTROCENTRUM Gorham

15. *unicolor* (White).

HYDNOCERINÆ

Genus **NEOHYDNUS** Gorham

16. *ater* sp. nov.
17. *attalus* sp. nov.
18. *auripilosus* sp. nov.
19. *bakeri* sp. nov.
20. *colon* sp. nov.
21. *constrictus* sp. nov.
22. *granulatus* sp. nov.
23. *luzonicus* sp. nov.
24. *pictus* sp. nov.
25. *pilosus* sp. nov.
26. *scutellatus* sp. nov.
27. *sexnotatus* sp. nov.
28. *tibialis* sp. nov.

Genus **BRACHYCALLIMERUS** novum

29. *latifrons* (Gorh.).

Genus **CALLIMERUS** Gorham

30. *albescens* Chpn.
31. *albus* Chpn.
32. *bakeri* Chpn.
33. *basilanicus* Chpn.
34. *bisoctonotatus* sp. nov.
35. *fenestratus* Chpn.
36. *flavus* Chpn.
37. *gratiosus* Gorh.
38. *intermedius* sp. nov.
39. *lateralis* Chpn.
40. *luzonicus* Chpn.
41. *octopunctatus* Heller.
42. *persimilis* Chpn.
43. *princeps* Chpn.
44. *pulchellus* Gorh.
45. *schultzei* Schklg.
46. *trifoliatus* sp. nov.

CLERINÆ

Genus **NOTOXUS** Fabricius

Genus **ANTHICOCLERUS** Schenkling

47. *anthicoides* (Westw.).

Genus **ORTHRIUS** Gorham

48. *bicrucis* sp. nov.
49. *binotatus* Fisch.
50. *pallidus* sp. nov.

Genus **PSEUDOMADIUS** novum

51. *viridiventris* sp. nov.

Genus **OMADIUS** Castelnau

52. *aurifasciatus* Gorh.
53. *aurulentus* Heller.
54. *bakeri* Heller.
55. *brunneus* sp. nov.
56. *centralis* (Gorh.).
57. *kamelianus* White.
58. *nimbifer* Gorh.
59. *notatus* Gorh.
60. *posticalis* Gorh.
61. *pruinosus* sp. nov.
62. *sibuyanus* sp. nov.
63. *vespiformis* Gorh.

Genus **OPERCULIPHORUS** Kuwert

64. *philippinus* sp. nov.

Genus **RHYTIDOCLERUS** Kuwert

65. *subfuscus* (Gorh.).

Genus **DASYCEROCLERUS** Kuwert

66. *banksi* Schklg.

Genus **THALEROCNEMIS** Lohde

67. *bakeri* sp. nov.
68. *variabilis* sp. nov.

Genus **PHAEOCYCLOTOMUS** Kuwert

69. *nigripes* sp. nov.
70. *tapetum* (Gorh.).

Genus **STIGMATIUM** Gray

71. *bakeri* sp. nov.
72. *encaustum* Gorh.
73. *laterifoveatum* Kuw.
74. *philippinarum* Gorh.
75. *sibuyanum* sp. nov.
76. *tuberculibase* Kuw.

Genus **COPTOCLERUS** novum

77. *albipictus* sp. nov.
78. *apicalis* sp. nov.
79. *binotatus* sp. nov.
80. *fasciatus* sp. nov.
81. *intricatus* sp. nov.
82. *obliquus* sp. nov.
83. *sericeus* sp. nov.
84. *triangularis* sp. nov.
85. *variegatus* sp. nov.

THANEROCLERINÆ

Genus **THANEROCLERUS** Lefebvre

86. *buqueti* Lef.

Genus **CYRTINOCLERUS** novum

87. *cyrtinoides* sp. nov.

ENOPLIINÆ

Genus **ALLOCHOTES** Westwood

88. *bakeri* sp. nov.
89. *maculatus* (Waterh.).
90. *pallidus* sp. nov.

Genus **TENERUS** Castelnau

91. *acostatus* sp. nov.
92. *basilanicus* sp. nov.
93. *cyanopterus* Spin.
94. *luzonicus* sp. nov.
95. *magnus* sp. nov.
96. *mindanaonicus* Gorh.
97. *nigripes* sp. nov.
98. *obscurus* sp. nov.
99. *philippinarum* Chevr.
100. *pulcher* sp. nov.
101. *sibuyanus* sp. nov.
102. *signaticollis* Cast.
103. *trinotatus* sp. nov.
104. *vittiger* sp. nov.

Genus **TENEROIDES** Gahan

105. *aurantiacus* sp. nov.
106. *bakeri* sp. nov.
107. *melanopterus* sp. nov.
108. *tuberculatus* sp. nov.

Genus **PARATENERUS** novum

109. *mindanensis* sp. nov.

Genus **TENEROPSIS** novum

110. *sibuyanus* sp. nov.

KORYNETINÆ

Genus **TARSOSTENUS** Spinola

111. *univittatus* Rossi.

Genus **NECROBIA** Olivier

112. *ruficollis* (Fabr.). 113. *rufipes* DeG.

TAXONOMY

CLERIDÆ

Family characters.—Coleoptera genuina, pentamera. Head prominent; eyes usually conspicuously emarginate; antennæ of eight to eleven segments, serrate, clavate or capitate; labrum corneous, usually emarginate; mandibles stout, with one or more internal teeth; maxillæ with two lobes, maxillary palp with terminal segment cylindrical to broadly triangular; labium small, labial palp with terminal segment usually triangular, sometimes cylindrical; gular sutures parallel, convergent anteriorly or convergent posteriorly. Thorax with or without a well-developed cariniform margin; anterior coxal cavities open, or closed by the complete junction of the internal muscle plates; mesosternum usually normal, sometimes vertical anteriorly; medial coxal cavities approximate; metasternum longer than either pro- or mesosternum; posterior coxal cavities narrowly separated. Scutellum small, always visible. Elytra of firm texture, usually covering the abdomen, in one subfamily (Hydnocerinæ) often abbreviated, abdomen with five or six visible sternites, corneous, often with coriaceous posterior margins, often some of the segments with secondary sexual modifications. Legs of normal form, posterior trochanters in one genus at least (*Teneroides* Gahan) modified in the male, tarsi with all segments distinct or with the first reduced in size or the fourth reduced, or both the first and fourth reduced, second and third and sometimes first or fourth with a lamella on the underside. Fifth segment longer than the fourth, claws simple, or with a basal platelike tooth or with a basal and median internal tooth.

The family Cleridæ is distributed over the entire world and exhibits a greater diversity of form than any other coleopterous family. Many genera show marked resemblance to genera of other families, such as the Lycidæ, Telephoridæ, Cerambycidæ, and Coccinellidæ.

For convenience I have included all the known subfamilies in the following key, although the subfamily Epiphloeinæ is not represented in the region under discussion:

Key to the known subfamilies of the Cleridæ.

1. Fourth segment of tarsus approximately equal in size to third............ 2.
   Fourth segment of tarsus small, usually indistinct, embedded between the lobes of the third........ 5.
2. Anterior coxal cavities completely closed externally and internally; first tarsal segment distinctly visible from above........ **Tillinæ.**
   Anterior coxal cavities always open internally, usually so externally.. 3.
3. Anterior tarsi broadly dilated, tarsal segments short and compact; eyes nearly entire; thoracic punctures elongate-oval, not circular. **Thaneroclerinæ.**
   Anterior tarsi of usual form; eyes usually distinctly emarginate; thoracic punctures circular........ 4.
4. Eyes deeply emarginate; first tarsal segment small, covered by the second .... **Clerinæ.**
   Eyes entire or virtually so, first tarsal segment variable.... **Hydnocerinæ.**
5. Anterior tibiæ spinulose, thorax with a pair of discal and a pair of lateral sensory setæ, eyes emarginate internally........ **Epiphloeinæ.**
   Anterior tibiæ not spinulose, sometimes finely serrate, thorax without sensory setæ, eyes emarginate anteriorly........ 6.
6. Antennæ serrate or with the terminal three segments long, forming a lax club, this club about as long as the preceding segments together. **Enopliinæ.**
   Antennæ with a short compact club of three segments which is always shorter than the rest of the organ........ **Korynetinæ.**

TILLINÆ

Subfamily characters.—Cleridæ; heard large or medium sized, eyes emarginate, antennæ eleven-segmented, serrate, flabellate or with a more or less well developed club, terminal segments of maxillary and labial palpi variable. Thorax with the anterior coxal cavities completely closed both externally and by the internal muscle-attachment plates. Elytra covering or almost covering the abdomen. Abdomen with six visible ventral segments. Tarsi with both the first and fourth segments well developed and visible from above. Tarsal claws usually with broad basal tooth and with a second sharp tooth internally, arising just beyond the basal.

Of the above-mentioned characters, the two which appear to me to be of greatest value are (*a*) the complete closing both externally and internally of the anterior coxal cavities and (*b*) the tripartite claws. I have been unable to find either of these characters in any genus not obviously tilline and it may be that such genera as *Diplophorus* Fairm. and *Diplopherusa* Heller

should be joined with *Axina* Kirby and *Priocera* Kirby, both of which have the first and fourth tarsal segments well developed, to form a group within the next subfamily. For the present, however, *Diplopherusa* Heller is considered as belonging to this subfamily. The Philippine tilline genera are distinguished by the following key:

Key to Philippine genera of Tillinæ.

1. Antennæ with a more or less distinct, four-segmented club. **Gastrocentrum** Gorham.
   Antennæ strongly serrate or flabellate from the third segment............ 2.
2. Head large, labrum concealed, epistoma denticulate.. **Cylidrus** Latreille.
   Head smaller, labrum visible, epistoma not denticulate.......................... 3.
3. Terminal segment of labial palp elongate, subcylindric, antennæ biramose. **Diplopherusa** Heller.
   Terminal segment of labial palp cultriform or securiform..................... 4.
4. Form very elongate, basal third of thorax very strongly strangulate. **Cladiscus** Chevrolat.
   Form cylindric, not very elongate, thorax constricted only at extreme base .... 5.
5. Thorax broadly dilated at middle, anterior transverse impression of thorax distinct, labrum feebly emarginate.......... **Cylidroctenus** Kraatz.
   Thorax with sides parallel, anterior transverse impression indistinct, labrum entire.. **Tillus** Olivier.

I have not seen specimens of *Diplopherusa* Heller, the characters used in the above key being taken from the original description. The genera *Tillus* Oliv. and *Cylidroctenus* Kraatz are rather close together and possibly do not deserve to be separated.

Genus CYLIDRUS Latreille

Cylidrus LATREILLE, Cuv. Reg. Anim. 4 (1829) (Crust., Arachn., Ins.) 476; SPINOLA, Monog. Clérites 1 (1844) 82; LACORDAIRE, Gen. Col. 4 (1857) 424; SCHENKLING, Gen. Ins. (Wytsman) Cleridae Fasc. 13 (1903) 5, Deutsche Ent. Zeit. (1906) 243.

Epiteles NEWMAN, Entomol. (1842) 403.

Generic characters.—Tillinæ; head prognathous, labrum deeply bilobed, epistoma emarginate, usually with five denticles. Mandibles stout, conical, with short internal teeth near base, terminal segment of maxillary palp elongate, cylindrical, somewhat enlarged at middle, that of labial palp long, slender, slightly curved, eyes moderately coarsely granulated, emarginate, not prominent. Antennæ eleven-segmented, segment 1 stout, somewhat bent, segments 2 to 4 slender, cylindrical, segments 5 to 11 broad and flat, trapezoidal. Thorax longer than broad, cylindrical, anterior coxal cavities closed. Elytra long, nearly covering body. Abdomen with six visible ventral segments,

secondary sexual modifications slight. Femora greatly enlarged, legs moderately short, tarsi with five segments, the first easily seen from above, second to fourth short, together but slightly longer than fifth. Claws large, with accessory tooth between basal process and apex.

Genotype, *Cylidrus cyaneus* (Fabr.).

The genus is distributed over the Ethiopian, Oriental, and Australian Regions, with one species reported from the Neotropical Region. One species is found in the Philippine Islands. It may be distinguished by the following characters:

Cylidrus cyaneus (Fabr.).

Clerus cyaneus FABRICIUS, Mant. Ins. (1787) 126; SPINOLA, Monog. Clérites 1 (1844) 85, pl. 1, fig. 3.

Head long, very rough, sparsely pubescent, the hairs arising from elongate flattened tubercles, median longitudinal line on frons smooth, postocular carina sharp and distinct, supra-mandibular carina short and high, eyes long and narrow, vertical, rather finely granulate. Thorax with the anterior portion narrowly but very strongly reticulate, disk smooth with few punctures, sides somewhat roughened and more densely hairy. Visible portion of scutellum nearly circular. Elytra broadest at about middle, very finely punctured, sparsely pubescent, lateral margin strongly beaded, suture without bead; elytra overlap toward apex. Underparts smooth, sparsely punctured; tibiæ more coarsely punctured. Upper parts metallic blue, abdomen and legs reddish testaceous. Length, 8 to 8.5 millimeters.

LUZON, Laguna Province, Los Baños, and Mount Maquiling (*Baker 253*). Collected on dead *Cyathocalyx globosa.*

This is a very widely distributed species, reported from most parts of the Malay Archipelago, Madagascar, and Africa.

Genus **CLADISCUS** Chevrolat

Cladiscus CHEVROLAT, Ann. Soc. Ent. France (2) 1 (1843) 33; LACORDAIRE, Gen. Col. 4 (1857) 427; SCHENKLING, Gen. Ins. (Wytsman) Cleridae, Fasc. 13 (1903) 10.

Generic characters.—Tillinæ; head hypognathous, labrum slightly emarginate or straight, epistoma variable, mandibles short and stout, with accessory tooth near apex, terminal segment of maxillary palp cylindrical, slightly thickened near middle, that of labial palp elongate-cultriform, eyes coarsely granulate, emarginate, prominent. Antennæ eleven-segmented, serrate or flabellate, first segment stout, second nearly spher-

ical, segments 3 to 10 either broadly triangular or narrow with long basal rami (in some exotic species the segments are biramose), eleventh segment elongate-oval or diamond-shaped. Thorax campanulate, at the base very strongly constricted, anterior coxal cavities closed. Elytra long, parallel, covering the abdomen. Abdomen with six visible ventral segments, the first longer than any of the others, secondary sexual modifications slight. Legs long and slender, tarsi with five segments, the first easily visible from above, fifth about as long as third and fourth together. Claws large, the internal tooth almost as long as apical portion of claw.

Genotype, *Cladiscus strangulatus* Chevr.

A genus of twenty-nine species, mainly found in the Oriental Region, though representatives have been taken in Madagascar and Africa. The material before me may be separated into seven species, of which five are as yet undescribed. The following key emphasizes the specific differences:

Key to species of Cladiscus Chevrolat.

1. Antennæ flabellate .... 2.
   Antennæ serrate .... 5.
2. Clypeo-frontal suture sinuate .... 3.
   Clypeo-frontal suture evenly curved, convexity anterior .... 4.
3. Disk of thorax very sparsely punctured; anterior margin of clypeus straight, extending between bases of mandibles; 10 millimeters.
   C. strangulatus Chevrolat.
   Disk of thorax moderately densely punctured; anterior margin of clypeus not straight throughout its length, the median portion being straight and distinctly in advance of the lateral extremities; 7.5 millimeters.
   C. clypealis sp. nov.
4. Frons distinctly bi-impressed, labro-clypeal suture straight between bases of mandibles, clypeus not horizontally impressed; 7.5 millimeters.
   C. vicinus sp. nov.
   Frons convex without trace of impressions, labro-clypeal suture somewhat as in *clypealis*, clypeus with deep horizontal impression; 9.5 millimeters.
   C. mindanensis sp. nov.
5. Head and thorax with large, evenly and widely spaced punctures, elytra black; length 6 millimeters; habitat northern Luzon.
   C. bacillus Heller.
   Head and thorax with fine punctures; elytra brown with black tips .... 6.
6. Basal two-thirds of elytra brown, tips of elytra smooth except for continuation of ninth and tenth rows of punctures as weak grooves, thorax without longitudinal groove .... **C. bicolor** sp. nov.
   Basal four-fifths of elytra brown, tips of elytra roughened by continuation of all puncture rows as grooves, thorax with longitudinal median groove .... **C. bakeri** sp. nov.

Cladiscus strangulatus Chevrolat.

Cladiscus strangulatus CHEVROLAT, Ann. Soc. Ent. France (2) 1 (1843) 33; LACORDAIRE, Gen. Col. Atlas (1857) pl. 45, fig. 4.

Black with the exception of the thorax which is reddish. Head coarsely and rather sparsely punctured, eyes prominent, coarsely granulate, antennæ reaching to base of thorax, first segment reddish, rami long and slender. Thorax very sparsely punctured, the punctures about same size as those of head, sides more densely punctured, sides of constricted portion longitudinally strigose, at base with two low rounded tubercles above. Elytra with ten rows of very large, quadrate punctures, these punctures wider than the interspaces and absent on apical fourth which is smooth with fine sparse punctures. Suture simple, lateral margin with strong bead. Pro- and mesosterna coarsely sculptured, metasternum smooth with fine punctures. Abdomen finely punctured. Fifth sternite with shallow, broad, even emargination. Legs rough, the tibiæ slightly bent. Entire insect sparsely covered with fine hairs. Length, 9.5 millimeters.

LUZON, Benguet Subprovince, Baguio (*Baker 11906*).

Originally described from the "Philippine Islands." This is the only species before me that satisfies Chevrolat's diagnosis. The members of this genus appear to me to be rather local and it is probable that many of the references in literature to this species apply to other closely allied forms. It has been reported from the "East Indies" by Schenkling (1910) and from numerous localities by the late Rev. H. S. Gorham.

Cladiscus clypealis sp. nov.

Similar to last but smaller and with much denser punctuation on head and thorax. Color bluish black, head may be black or reddish, thorax reddish. Head more evenly punctured, frons feebly bi-impressed, antennæ reaching well beyond base of thorax, which is more evenly and densely punctured. Constricted portion and base of thorax as in *strangulatus* Chevr. Elytra long and parallel, sculpture as in *strangulatus* Chevr. but with the individual punctures smaller, about equal in width to the interspaces. Underparts more heavily sculptured than in the preceding species, fifth sternite and legs as in the preceding. Length, 7.5 millimeters.

LUZON, Laguna Province, Mount Maquiling: Benguet Subprovince, Baguio (*Baker*). Type from Mount Maquiling.

Cladiscus vicinus sp. nov.

Similar in appearance to *clypealis* sp. nov., but more coarsely sculptured throughout. Black, thorax reddish. Punctures of head coarse, not sharply defined, moderately dense. Thorax especially at anterior margin densely punctured; constricted portion of thorax with five longitudinal ridges on each side, basal margin of thorax with distinct bead. Elytra long and parallel, the punctures very large, the interspaces about half as wide as the punctures themselves; the punctures are so crowded as to make the interspaces irregular, producing the effect of reticulations. Underparts not as coarsely sculptured as in *clypealis* sp. nov. Fifth sternite nearly straight across. Tibiæ straight. Length, 7.5 millimeters.

LUZON, Benguet Subprovince, Baguio (*Baker 6076*).

Cladiscus mindanensis sp. nov.

Bluish black, thorax reddish. Head and thorax moderately, finely, and densely punctured, antennæ about as long as head and thorax together, constricted portion of thorax with indistinct ridges, apparently eight in number. Basal margin beaded. Elytral punctures large, quadrate, wider than interspaces, with distinct setigerous punctures along tops of interspaces, apices of elytra less abruptly rounded than in preceding species. Sculpture of underparts fine and dense, fifth sternite almost straight across, sixth more deeply emarginate. Legs slender, tibiæ slightly bent. Length, 9.5 millimeters.

MINDANAO, Bukidnon Province, Tangkulan. BASILAN (*Baker*). Type from Tangkulan.

Cladiscus bacillus Heller.

Cladiscus bacillus HELLER, Philip. Journ. Sci. **19** (1921) 531, pl. 1, fig. 7.

Color varies from black to reddish brown on head and thorax. Head rather sparsely but deeply punctured, antennæ almost reaching base of thorax. Thorax more densely punctured than in the species of the last section, punctures deep and distinct; constricted portion of thorax with nine or ten longitudinal ridges of varying lengths, basal tubercles almost fused. Elytra long, parallel, convex, their tips truncate and minutely serrate. Punctures large, interspaces narrow with setigerous punctures. Underparts rather sparsely punctured, the metathorax alutaceous. Fifth sternite broadly and shallowly emarginate, sixth entire.

Legs heavily sculptured, tibiæ rather stout and straight. Length, 6.5 millimeters.

LUZON, Benguet Subprovince, Baguio (*Baker 11907*).

The specimens before me differ in no wise from the original description.

Cladiscus sanguinicollis Spinola. Plate 1, fig. 2; Plate 3, fig. 22.

Cladiscus sanguinicollis SPINOLA, Monog. Clérites 1 (1844) 125.

This species was described from a mutilated specimen said to have come from Manila. I have seen no specimens that fit the description from the Philippine Islands but have a series taken at Singapore by Professor Baker. It is doubtful whether the specific name should be continued in the Philippine list. Schenkling (1910) reports the species from "Ostindien, Andamanen."

Cladiscus bicolor sp. nov.

Head, mouth parts, thorax, pro- and mesosterna, anterior and mesial coxæ, and basal two-thirds of elytra brown, rest of insect black. Head at sides and on vertex closely punctured, antennæ very much longer than head and thorax. Thorax finely punctured, almost rugose at sides; constricted portion longitudinally strigose, basal tubercles fused, basal margin with fine bead. Elytra long and narrow, not quite four times as long as wide, punctures large, quadrate, about equal in width to interspaces, apical portion smooth, finely punctured, apices slightly truncate. Underparts finely sculptured, fifth sternite broadly triangularly emarginate, sixth truncate. Legs heavily sculptured, tibiæ rather stout and nearly straight. Length, 8 millimeters.

MINDANAO, Dapitan (*Baker*).

Related to *C. parrianus* Westw., from "Inde orientale," but differs especially in the length of the antennæ, which in *C. parrianus* are not as long as head and thorax together.

Cladiscus bakeri sp. nov.

Somewhat of the appearance of *C. bicolor* sp. nov. but proportionately much longer. Head, mouth parts except tips of mandibles, thorax, pro- and mesosterna, anterior and mesial coxæ, and basal four-fifths of elytra brown. Head evenly and finely punctured. Clypeus with strong transverse ridge, antennæ as long as head and thorax together. Thorax slightly rugose, the individual punctures distinct only on anterior portion, with a

median longitudinal groove running from anterior constrictions nearly to base, basal tubercles separate, basal margin beaded. Elytra long and narrow, five times as long as wide, punctures quadrate, larger than width of interspaces, apical portion grooved by continuation of puncture rows. Apices evenly rounded. Underparts finely (on the thorax very densely) punctured, fifth sternite with a semicircular emargination occupying the median three-fourths of the width, sixth slightly emarginate. Legs heavily sculptured, tibiæ curved at base. Length, 11.5 millimeters.

MINDANAO, Surigao (*Baker*).

Also related to *C. parrianus* Westw.

Genus DIPLOPHERUSA Heller

Diplopherusa HELLER, Philip. Journ. Sci. 19 (1921) 530.

This genus was based upon a single individual of a new species from Mount Banahao, Luzon. As I have seen no specimens that may be referred here, I quote the original descriptions of genus and species.

Genus DIPLOPHERUSA novum

Tillinorum prope Cladiscus

Antennae ab articulo tertio longe biramosae. Labrum recte truncatum. Palpi maxillares articulo ultimo breviter subcylindrico, palpi labiales articulo ultimo perlongo, cylindrico, acuminato. Oculi transversi, reniformes. Prothorax latitudine haud longior, globosus, basi fortiter constrictus. Tibiae anticae rectae, posticae tumidae. Unguiculi in dimidia parte basali dentato-dilatati.

Diplophorus Fairm. has similar, but much shorter bipectinate antennae; notwithstanding this the new genus is more closely allied to *Cladiscus*. It is distinguished from *Cladiscus* by the long bipectinate antennæ, as well as by the very long apical joint of labial palpi which is six times longer than thick; the medially subtransversely spheric thorax; the thickened hind tibiæ; and the broadly dentate unguiculi.

The above remarks concerning the relationship of the genus should be somewhat modified. For instance, *Cladiscus laniger* Schklg. from Sumatra has biramose antennæ and moderately long labial palpi; *C. laniger* Schklg. is a somewhat aberrant member of the genus, the elytra are furnished with longitudinal elevated ridges as in certain hispids. The thorax does not conform to the usual shape and sculpture, nor is the head typical. An examination of other species now unknown to me may indicate a division of the genus along the above-mentioned lines.

Diplopherusa tumidipes Heller.

Diplopherusa tumidipes HELLER, Philip. Journ. Sci. **19** (1921) 531, pl. 1, fig.6.

Heller's description is as follows:

Nigro-cyanea, antennis atris, articulis 3 ad 10 subter longe biramosis, elytris palpisque testaceis; prothorace margine basali sanguineo, creberrime punctato, margine antico leviusculo, parte basali constricto transverse subrugoso; elytris crebre seriato-punctatis, in dimidia parte, minore, apicali, dense punctulatis; tibiis posticis fortiter clavatis.

Long. 11 mm. lat. 2.2.

Luzon, Mount Banahao.

Body dark steel blue, thorax coarsely and densely punctate, in the apical part with fine and scattered punctures, on the contracted basal part tranversely wrinkled, the basal margin dark red; elytra pale cinnamon in color, in the basal two-thirds coarsely and subtransversely seriate-punctate, on the posterior third with irregular fine and dense punctures; hind tibiæ strongly clavate.

There should be no difficulty in recognizing the species from the above description.

Genus **CYLIDROCTENUS** Kraatz

Cylidroctenus KRAATZ, Ann. Soc. Ent. Belg. **33** (1899) 214; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 37.

Cylindroctenus SCHULTZE, Philip. Journ. Sci. § D **11** (1916) 45 (misprint).

Hardly to be separated from *Tillus* Olivier. Thorax broadly rounded at sides, anterior constriction deeper than in *Tillus*. Labrum feebly emarginate. Otherwise similar to *Tillus*.

Genotype, *Cylidroctenus chalybeus* (Westwood).

The only member of this genus is widely distributed over Malaysia. The following description has been prepared from examples from the Philippine Islands:

Cylidroctenus chalybeus (Westwood).

Tillicera chalybeum WESTWOOD, Proc. Zool. Soc. London (1852) 41, pl. 24, fig. 5; KRAATZ, Ann. Soc. Ent. Belg. **33** (1899) 214.

Entirely metallic blue except for postmedian spot which is reddish orange and mouth parts which are black. Head finely and sparsely punctured, eyes rather prominent, antennæ with segments 2 and 3 nearly equal, segment 4 elongate-triangular, segments 5 to 10 broadly triangular, terminal segment oval, entire organ slightly longer than head and thorax together. Thorax strongly dilated above and at sides, rather densely and

evenly punctured, pubescence at sides pale, not dense. Scutellum densely covered with silvery hairs. Elytra with ten rows of coarse punctures at base, sutural row fails before middle of length, fourth row ends at sutural end of orange spot, which is transversely oblong and reaches the lateral margin; the humeral callus is impunctate, puncture rows 7 and 8, directly back of humeral callus, are badly confused, apices of elytra back of orange spot are evenly and finely punctate. Underparts, except for lateral portions of first sternite which are smooth, evenly and rather densely punctate, moderately densely pubescent. Legs short, femora stout, tibiæ densely hairy, tarsi moderately long, claws with broad basal appendage and accessory tooth. Length, 6 to 8.5 millimeters.

Specimens from Iligan and Kolambugan, Mindanao, and Mount Limay, Luzon, have been examined. There is little variation shown other than in size. A handsome and striking species, accurately figured by Westwood.[1]

Genus TILLUS Olivier

Tillus OLIVIER, Ent. No. 22 2 (1790);, SPINOLA, Monog. Clérites 1 (1844) 92; LACORDAIRE, Gen. Col. 4 (1857) 428; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 12; Cat. Col. (Junk) Cleridae (1910) 11; GAHAN, Ann. & Mag. Nat. Hist. VIII 5 (1910) 62.
Cylinder VOLT, Cat. Syst. Col. 1 (1806) 78.
Tilloidea CASTELNAU, Ann. Soc. Ent. France (1) 1 (1832) 398.

A revision of the genus *Tillus* Olivier would undoubtedly result in the formation of several groups of species under separate generic names, and *Tilloidea* Castelnau would be reëstablished as a valid genus. The Philippine species are more nearly related to *T. unifasciatus* Oliv., the type of *Tilloidea* Cast., than to *T. elongatus* (Linn.), which is the type of *Tillus*. The following generic diagnosis refers to the Philippine species and not to *Tillus elongatus* (Linn.):

Generic characters.—Tillinæ; head short and round, vertical, labrum broad and entire, mandibles stout with internal tooth beyond middle, terminal segment of maxillary palp elongate-cylindrical, slightly acuminate, that of labial palp broad, somewhat triangular, eyes finely granulate, emarginate, rather prominent; antennæ eleven-segmented, first segment stout, slightly bent, second and third short, nearly equal in length, the

[1] Proc. Zool. Soc. London (1852) 41, pl. 24, fig. 5.

second thicker than third, fourth to sixth roughly triangular, each slightly broader than the preceding, seventh to tenth transversely quadrate, the outer margin curved, mutually equal or nearly so, eleventh longer and oval. Thorax as wide as head, sides parallel nearly to base, disk strongly convex, suddenly and strongly constricted at base, anterior coxal cavities completely closed behind. Elytra long, covering body, suture closed. Abdomen with six visible ventral segments, the first longer than any of the succeeding. Secondary sexual modifications slight. Legs moderate in length, femora stout, tibiæ straight, tarsi moderately broad and short, first segment longer than second, second to fourth subequal, broadly lobed, fifth longer. Claws curved, with basal process and accessory tooth, which is similar to and about as long as apical portion of claw.

Genotype, see discussion immediately preceding generic characters.

Tillus is an Old World genus, and the New World species that have been referred to it are not congeneric. Of the nearly forty species described, four are inhabitants of the Philippines. These may be differentiated by means of the following key:

Key to Philippine species of Tillus Olivier.

1. General color blue or blue black........ 2.
   General color black with red or brownish patches........ 3.
2. Elytra bifasciate, the first fascia near the base and not reaching either margin of elytra, the second postmedian, reaching outer margin but failing suture, somewhat angulate at middle. Length, (3.5 lines) 7.3 millimeters........ **T. bifasciellus** White.
   Elytra each with basal and apical spot and a postmedian transverse bar broken at suture, each elytron with a short carina near base, in the second interval. Length, 5.5 millimeters........ **T. carinatulus** Schklg.
3. Elytra entirely black or with the basal portion reddish, with a postmedian band (broken at suture) and apices, dirty white. Length, 4 to 6 millimeters........ **T. notatus** Klug.
   Eytra black with a sutural brownish plagia of irregular extent; each elytron with a short deep groove in the second interval near the base; postmedianly there is a short transverse whitish spot starting at the outer margin and not extending more than halfway to suture. Length, 6 millimeters........ **T. mindanensis** Chapin.

Tillus bifasciellus White.

Tillus bifasciellus WHITE, Cat. Cler. Brit. Mus. (1849) 49.

As I have not seen this species I quote the original description in its entirety.

Tillus bifasciellus, n. s.

Serrated part of antennæ with eight joints. Head, thorax, abdomen, and elytra of a deep blackish blue. Head and thorax polished, covered, especially on the sides, with longish ashy hairs. Elytra punctato-striate for rather more than half their length, with two transverse yellow bands, the first not far from the base, and not reaching either margin of the elytron; the second just beyond the middle, reaching the outer edge of elytron, but not extending to suture, somewhat angulated in the middle. The tip of each elytron closely covered with ashy silk-like hairs; sides of terminal segments of abdomen beneath with close silky hairs. Length 3½ lines.

Hab. Philippine Islands.

It may be noticed that this description fits specimens of *Cylidroctenus chalybeus* (Westwood) in all points except for the presence of a subbasal spot on each elytron. It is possible that the two names may refer to varieties of the same species.

Tillus carinatulus Schenkling.

Tillus carinatulus SCHENKLING, Deutsche Ent. Zeit. (1908) 364.

Bluish black, shining; elytra with postmedian transverse fascia, subbasal and apical round spots yellow. Head almost impunctate, thickly clothed with white hairs, antennæ as in *T. notatus* Klug. Thorax distinctly punctured, flanks with white pubescense. Elytra with rows of punctures extending to transverse fascia, with a short dirty yellow longitudinal carina in the second interval just before the base, at the side of which is an irregular spot of sulphur yellow; just behind the middle is a transverse bar of pale yellow which is rounded anteriorly and fails to reach the suture; subapically there is a round brighter yellow spot; the apices are pubescent with white hairs.

Described from specimens in the British Museum from Mindoro.

The species is unknown to me except from description. The basal and apical spots are absent in all other species known to me from the Islands and should afford an easily recognized character for distinguishing the species.

Tillus notatus Klug. Plate 1, fig. 3; Plate 3, fig. 24.

Tillus notatus KLUG, Clerii (1842) 276; SCHENKLING, Deutsche Ent. Zeit. (1908) 363.

Tillus bipartitus BLANCH., Voy. Pôle Sud 4 (1853) 59, pl. 4, fig. 13; LESNE, Bull. Soc. Ent. France (1909) 206.

Tillus lewisi GORHAM, Trans. Ent. Soc. London (1878) 160.

Tillus multicolor FAIRMAIRE, Ann. Soc. Ent. France VI 6 (1886) 43; LESNE, Bull. Soc. Ent. France (1909) 206.
Tillus quadricolor HELLER, Philip. Journ. Sci. 19 (1921) 534, pl. 1, fig. 9.
Tillus semperanus GORHAM, Cist. Ent. 2 (1876) (1875–1882) 62.

Form depressed-cylindrical, ground color variable, from all black to black with greater part of thorax and basal half of elytra reddish; elytra with a postmedian and a subapical transverse fascia of white, the space between the fasciæ sometimes dirty white. Head shining, almost impunctate, antennæ black with the first two or three segments usually reddish. Thorax finely and more densely punctured, moderately densely clothed with long black and gray hair, the extreme base with a narrow band of short white hair. Basal half of elytra with ten rows of coarse punctures, apical half very finely and irregularly punctured. At the end of the rows of punctures there is a transverse bar of ivory white, slightly raised and smooth. Tips broadly whitish, extreme tips narrowly black. The black form, which is the typical *T. notatus* Klug (*Baker 1976, 14663,* Los Baños), is entirely black except for above-mentioned markings. A specimen from Medan, Sumatra (*Corporaal*) has the thorax entirely black and the basal third of the elytra reddish, the posterior limit of the red is oblique, reaching further posteriorly on the suture than on the margin. The same type of coloration is represented by a specimen from Los Baños (*Baker 263*) except that the base of the thorax is very narrowly red. A specimen from Leyte (*Baker*) is similar to the last except that the thorax is only one-half black, the posterior half of the same color as the base of the elytra. Finally, from Los Baños (*Baker*) I have a specimen which fits the description and figure of *Tillus quadricolor* Heller in all respects, in which the thorax and basal half of the elytra are as in the Leyte individual but the space between the pale fasciæ is brownish white, the limits of the original markings still perceptible. There appears to be not the slightest variation in sculpture or proportional dimension which can be coördinated with the variations in color. Underparts varying from all black in the dark specimens to black with the sterna reddish in the variegated specimens. Length, 4 to 7 millimeters.

A widely distributed species, very variable in color. Many of the color forms have received names as is indicated by the

above-listed synonymy, but as there appears to be a total absence of structural variation among them it seems best to suppress the names.

Tillus mindanensis Chapin.

Tillus mindanensis CHAPIN, Proc. Biol. Soc. Wash. 32 (1919) 225.

Form and size of *T. notatus* Klug. Black, elytra with a central longitudinal brownish plagia and a transverse ivory white spot slightly postmedian on either side. Head black, shining, almost impunctate, antennæ as in *T. notatus,* the three basal segments piceous; mouth parts piceous except for the mandibles, which are black. Thorax slightly swollen at sides, feebly narrowed in front, strongly constricted behind, shining, finely and sparsely punctured, evenly pubescent with pale hair. Scutellum densely pubescent with white hair. Elytra long, slightly wider at apical fourth, striate-punctate on basal half, finely and irregularly punctured on apical half. Near the scutellum, between the first and second rows of punctures there is a deep longitudinal pit, as long as the distance between the third and fifth punctures of the first row. The elytra are black except for the central brown portion bounded as follows: At the base by the fourth row of punctures, thence toward the apex to about basal fourth where it is suddenly narrowed to the second row. At about the middle it is suddenly widened into a triangular lateral expansion, the outer angle of which coincides with the end of the ivory white transverse bar on the fifth row of punctures. The brown plagia disappears shortly behind the white spot and is resumed in the form of a subapical spot, common to the two elytra. The white spot reaches the lateral margin. The surface bears a few upright black spinelike hairs and toward the apex is rather densely covered with gray pile. Underparts black, shining, sparsely and finely punctured. Flanks of metasternum and abdomen covered with silvery hairs. Legs black except for apical half of tibiæ and the whole of the tarsi which are rufopiceous. Length, 5.5 millimeters.

MINDANAO, Davao (*Baker 4268*).

It may be noticed that two of the four species of *Tillus* from the Philippine Islands have some sort of modification on the elytra near the scutellum. A species from Borneo, *T. nitidicollis* Chpn., falls also into this category. A study of other species of the genus may show a similar modification, and the character may prove of value in separating certain closely allied species.

Genus GASTROCENTRUM Gorham

Gastrocentrum GORHAM, Cist. Ent. 2 (1876) 63; SCHENKLING, Gen. Ins. (Wytsman) Cleridae, Fasc. 13 (1903) 22; GAHAN, Ann. & Mag. Nat. Hist. VIII 5 (1910) 61.

Generic characters.—Tillinæ; head hypognathous, labrum broadly angulately emarginate, mandibles stout, with internal tooth beyond middle, terminal segment of maxillary palp large, cylindrical, somewhat thickened at middle, that of labial palp securiform, almost as broad as long; antennæ eleven-segmented, first segment stout, longer than thick and somewhat bent, second short and globular, third longer than any of the following segments, 4 to 7 short, equal, moniliform, 8 to 10 broader than long, somewhat triangular, eleventh somewhat longer than tenth, cultriform, segments 8 to 11 opaque. Thorax longer than broad, sides somewhat gibbose, anterior coxal cavities closed behind. Elytra long, parallel, convex, covering body. Abdomen with six visible ventral segments, the first as long as the second and third together, intercoxal process of first segment conspicuous, grooved longitudinally. Secondary sexual modifications slight. Legs moderately long and stout, tarsi broad, first tarsal segment shorter than second but distinctly visible from above, second to fourth subequal, fifth longer. Claws long and curved, basal process small, inconspicuous, accessory tooth similar to and almost as large as apical portion of claw.

Genotype, (*Gastrocentrum pauper* Gorh. 1876) = *Gastrocentrum unicolor* (White) 1849.

The genus is represented in the Philippines by its type species.

Gastrocentrum unicolor (White). Plate 1, fig. 4.

Tillus unicolor WHITE, Cat. Cler. Brit. Mus. (1849) 56.
Gastrocentrum pauper GORHAM, Cist. Ent. 2 (1876) (1875–1882) 63.

Dark castaneous. Head with epistoma broadly emarginate, eyes large, prominent, distinctly margined, head finely and densely punctured, sparsely covered with short fine golden pubescence. Thorax with sides sinuate, variable within the species, longer than broad, constricted basally, basal margin fine and distinct, surface very finely and densely punctured. Visible portion of scutellum transversely oval. Elytra long, parallel, convex above, tips together rounded, suture finely margined, punctures nearly circular, arranged in about fifteen rows, in some specimens many of the punctures are entirely absent, punctures disappear on declivity; surface between punctures minutely punctulate; elytra densely and evenly covered with fine short golden pubescence. Underparts finely punctured,

densely pubescent. Legs rugose, bases of femora and apices of tibiæ paler in color. Length, 9 to 16 millimeters.

MINDANAO, Davao and Dapitan (*Baker 7285, 13516*).

HYDNOCERINÆ

Subfamily characters.—Cleridæ; head with eyes, which are very large and hemispherical, wider than thorax; antennæ eleven-segmented with a two- to five-segmented club; terminal segment of maxillary palpi cylindro-acuminate, that of labial palpi large, elongate-triangular. Thorax laterally dilated before the middle, anterior coxal cavities very widely open behind. Elytra completely covering the abdomen or abbreviated, elytral punctures variable. Terminal segments of abdomen, especially in the male, with sexual modifications. Legs long and slender.

There are three genera in the Philippine fauna that may be referred to this subfamily, one of which has up to this time been placed in the Tillinæ, and one characterized here for the first time. The reasons for the change in position of this genus have been reviewed in the introductory part of this paper. The following key serves to point out the conspicuous differences among the three:

Key to the Philippine genera of the subfamily Hydnocerinæ.

1. First tarsal segment small, covered by the second; size small, less than 5 millimeters .... **Neohydnus** Gorham.
   First tarsal segment long, not covered by the second; size larger, over 5 millimeters .... 2.
2. Form elongate, slender, parallel; elytra with pattern of scales; antennal club of three segments .... **Callimerus** Gorham.
   Form broad and compact; elytra never with scales; antennal club of five segments .... **Brachycallimerus** g. nov.

Genus **NEOHYDNUS** Gorham

Neohydnus GORHAM, Ann. Mus. Stor. Nat. Genova **32** (1892) 742; SCHENKLING, Gen. Ins. (Wytsman) Cleridae, Fasc. 13 (1903) 94; Col. Cat. (Junk) Cleridae, Paris **23** (1910) 107.

Generic characters.—Hydnocerinæ with the first tarsal segment short. Head vertical; labrum entire; mandibles stout, falcate, with short internal tooth toward apex; terminal segment of maxillary palpi cylindro-acuminate, that of labial palpi dilated, elongate-triangular; antennæ short, capitate, apparently ten-segmented (the tenth and eleventh segments being ankylosed), first segment short and thick, slightly bent, second nearly spherical, third to ninth trapezoidal, becoming successively shorter to eighth or ninth, ninth sometimes longer than

eighth, tenth and eleventh together oval and flattened; eyes large and convex, finely granulated, minutely emarginate at base of antennæ. Thorax with length and breadth subequal, slightly dilated at sides, lateral foveæ above dilations 2 or 3, usually distinct, anterior coxal cavities widely open behind. Elytra usually as long as body, suture slightly dehiscent toward apices, lateral margin and tips usually strongly serrate, punctuation irregular, never in longitudinal rows. Abdomen with six visible ventral segments. Sexual modifications of males usually conspicuous. Legs slender, femora somewhat swollen; tarsi short, of five segments, first segment short and ventral to second, claws with a broad basal process.

Genotype, *Neohydnus despectus* Gorham. Monobasic.

Geographic range, Indo-Malaysia.

There appears to be very little other than habitat to separate these forms from the American genus *Hydnocera* Newman and a better knowledge of the entire Indo-Malayan fauna may show the necessity of uniting the two genera under the latter name. On the other hand, continued study of a group often discloses certain characters, previously overlooked or considered of little importance, that serve to sustain what appeared to be bad judgment of a previous author.

One species of this genus, *Neohydnus pallipes* Kr. (Plate 1, fig. 5; Plate 3, fig. 26), has been reported from the Philippine Islands. While it may be found at some future time in Mindanao or Basilan, it seems to me very unlikely. The type locality for the species is Sumatra, and I have seen specimens from Singapore and Borneo. The Bornean individual, however, is not typical and might easily be considered specifically distinct. Considering the amount of variation seen here, together with the lack of variation along the same lines displayed in a series from Sumatra, I am inclined to believe that the nearest Philippine relative of the species would have to be considered as another species. Disregarding the above species, there are now thirteen species of the genus before me from the Islands which may be distinguished inter se by means of the following key:

Key to Philippine species of Neohydnus Gorham.

1. Pubescence of elytra not in patches but evenly distributed over the entire surface .... 2.
   Pubescence of elytra in patches, distinctly visible when the insect is held in certain positions .... 9.
2. Elytra unicolorous .... 3.
   Elytra maculate or striped .... 7.

3. Form depressed, elytra at apical fourth wider than at base, head and thorax nearly equal in width and narrower than base of elytra, tips of elytra apparently entire .... **N. attalus** sp. nov.
   Form somewhat convex, parallel, tips of elytra strongly serrate .... 4.
4. Surface of elytra between punctures smooth and shining .... 5.
   Surface of elytra between punctures finely granulate or alutaceous, opaque .... 6.
5. Punctuation of elytra very coarse, punctures of thorax very coarse and sparse .... **N. bakeri** var.
   Punctuation of elytra moderately fine and dense, thorax with very fine punctures, almost impunctate .... **N. luzonicus** sp. nov.
6. Terminal dorsal abdominal segment of male evenly rounded, last complete ventral with three triangular projections.
   N. granulatus sp. nov.
   Terminal dorsal with median lobe, last complete ventral not produced.
   N. auripilosus sp. nov.
7. Elytra striped, the pale stripe commencing at base and continuing indefinitely toward apex, dark portions iridescent .... **N. pictus** sp. nov.
   Elytra maculate but never pale at base .... 8.
8. Each elytron with a pale spot at apical third .... **N. colon** sp. nov.
   A large, transversely oval pale spot at basal third common to both elytra, apices sometimes pale .... **N. bakeri** sp. nov.
9. Disk of thorax smooth, shining, almost impunctate .... 10.
   Disk of thorax wrinkled or alutaceous .... 11.
10. Each elytron with basal, median, and apical spots of golden pubescence; surface of elytra between punctures alutaceous.
    N. sexnotatus sp. nov.
    Each elytron with postmedian and apical spots of pubescence; surface shining, punctures shallow and well separated ...... **N. tibialis** sp. nov.
11. Pubescence of scutellum, median transverse arcuate fascia, and subapical fascia of silvery pubescence .... **N. scutellatus** sp. nov.
    Scutellum not conspicuously pubescent .... 12.
12. Pubescence aureous, extending entire length of suture, with lateral outgrowths near base, postmedianly and at apex, outer margin near apex pubescent; punctures of elytra coarse and rather sparse.
    N. pilosus sp. nov.
    Pubescence argenteous, restricted to three spots on each elytron; punctures coarse and crowded .... 13.
13. Anterior thoracic impression composed of a series of pits, beadlike; elytra with lateral margins parallel .... **N. constrictus** sp. nov.
    Anterior thoracic impression not composed of pits but of parallel grooves; elytra wider at apical fourth than at base.
    N. ater sp. nov.

Neohydnus attalus sp. nov.

Form depressed, head and thorax narrow, elytra widest toward apices. Color black except for antennæ, mouth parts, and portions of legs, which are testaceous. Head (including eyes) with nearly circular outline, very finely punctured, and sparsely set with silvery hairs; antennæ rather short, with the sixth and eighth segments smaller than the fifth, seventh, or ninth.

Thorax slightly wider than long (30–32), anterior and basal transverse impressions deep and distinct, surface very uneven but without distinct punctures and with a short median longitudinal carina extending from anterior groove one-third distance toward basal, sides somewhat dilated and with two unequal foveæ, the anterior one the larger. Elytra at widest part half again as wide as at humeri, coarsely and closely punctured, suture strongly beaded, lateral margin and tips, which are subtruncate, feebly serrate; surface of elytra and thorax sparsely set with whitish hairs. Underparts shining black, very finely and sparsely punctured. Legs black except for inner portions of anterior femora and tibiæ, all tarsi and trochanters, and tips of hind tibiæ which are whitish. Length, 3.5 millimeters.

Type, a specimen, sex uncertain, from Mount Maquiling, Laguna Province, Luzon (*Baker*).

Neohydnus ater sp. nov.

Form somewhat as in *attalus* but more elongate. Color black, appendages slightly paler. Head very finely punctured, sparsely clothed with silvery pubescence; antennæ short, segments distinctly punctured, club oval. Thorax equilateral, surface finely pebbled, anterior transverse impression broad and shallow, composed of several parallel grooves, basal impression distinct, lateral dilation feeble, lateral foveæ triple, almost confluent. Elytra broader toward apices than at base, coarsely and closely punctured, each with a small irregular spot of silvery hairs near basal fourth, a second, somewhat larger, postmedian, and a patch of sparsely placed hairs at apex, suture, and lateral margins strongly beaded, lateral margin and apices serrate. Underparts finely punctured, not conspicuously pubescent. Length, 3.5 millimeters.

Type, a specimen, female?, from Baguio, Benguet Subprovince, Luzon (*Baker*).

Easily separated from *N. attalus* by the structure of the thorax and by the presence of patches of scales on the elytra.

Neohydnus bakeri sp. nov.

Form parallel, rather convex above. Head and thorax black, elytra bluish black with a transverse oblong testaceous spot common to both at basal fourth (sometimes reduced or absent), underparts black, antennæ, mouth parts, and legs rufotestaceous. Head almost impunctate, clypeus and frons densely covered with short silvery pubescence; antennæ short, club tri-

angular, abruptly truncate at tip. Thorax broader than long (30–37), anterior transverse impression conspicuous, distant from anterior margin, posterior impression deep and well defined, lateral dilation moderate; lateral foveæ triple, most posterior one shallow, surface finely wrinkled, almost alutaceous. Elytra long, suture closed, lateral margins and tips rather coarsely serrate, punctures coarse, densely and evenly distributed. Pubescence sparse, evenly distributed. Apices separately rounded. Underparts finely, almost imperceptibly punctured. Legs moderately long, tarsi rather short. Length, 3.5 millimeters.

Male.—Fifth ventral with a long sharp median denticle, which is almost as long as the average length of the segment.

Female.—Ventral segments unmodified.

Type, a male from Basilan (*Baker 11881*); paratypes, specimens of both sexes from Basilan (*Baker 11880, 11882*) and from Surigao, Mindanao (*Baker*).

The single spot on the elytra varies considerably in size, and in two specimens is entirely absent.

Neohydnus luzonicus sp. nov.

Form elongate, parallel, depressed. Color greenish black except for the antennæ, mouth parts, and legs, which are testaceous. Head finely and sparsely punctured, moderately densely clothed with short pale golden pubescence; antennæ with eighth segment smaller than seventh or ninth. Thorax broader than long (26–31), slightly swollen at sides, anterior and basal transverse impressions distinct, lateral foveæ triple, the most posterior one poorly defined, median line broad and impunctate, other portions rough with a few fine punctures. Elytra closely and coarsely punctured, the punctures not sharply delineated; suture strongly beaded and closed almost to apex, lateral margins and apices serrate; apices separately rounded; surface evenly and not densely covered with pale pubescence. Underparts finely and more densely punctured, legs pale, tips of tarsi darker. Length, 3 to 4.5 millimeters.

Male.—Fifth ventral segment feebly emarginate, slightly protuberant at middle, last dorsal truncate.

Female.—Ventral segments unmodified, simple.

Type, a male from Mount Maquiling, Laguna Province, Luzon (*Baker 2406*); paratypes, specimens from Los Baños, Laguna Province, Luzon (*Baker 8289*) and from Baguio, Benguet Subprovince, Luzon (*Baker 6075*).

Neohydnus granulatus sp. nov.

Form elongate, parallel. Color black, elytra with slight bluish reflections, antennæ, mouth parts, and tarsi piceous, legs rufotestaceous. Head almost impunctate, sparsely covered with a mixture of golden and silvery pubescence; club of antennæ oval. Thorax wider than long (36–43), anterior transverse impression much confused on disk, consisting at that point of at least five distinct parallel grooves, basal impression deep, distinct, single; surface, especially between anterior margin and anterior impression, wrinkled, disk smoother with a few scattered setiferous punctures; lateral dilation moderate, lateral foveæ triple as in *N. bakeri*. Elytra long and narrow, suture closed almost to tip, surface rather finely and closely punctured, punctures shallow and not well defined, surface between punctures alutaceous; lateral margins and tips rather coarsely serrate, tips separately rounded. Pubescence fine, sparse, erect, pale. Underparts finely and sparsely punctured, legs long and slender. Length, 4.5 millimeters.

Male.—Fifth ventral tridentate, the teeth triangular and so arranged as to divide the width of the segment into fourths.

Female.—Unknown.

Type, a male from Dapitan, Zamboanga Province, Mindanao (*Baker*).

Neohydnus pictus sp. nov.

Form parallel, rather abruptly narrowed behind, convex above. Head and thorax greenish black, suture and lateral margins of elytra metallic green, iridescent, discal portion of elytra, antennæ, mouth parts and legs testaceous, underparts black. Head shining, no punctures visible under moderate powers; antennæ short, about as long as longest diameter of eye. Thorax slightly broader than long (30–35), anterior transverse impression shallow, basal deeper, surface finely alutaceous, lateral impressions triple, round and deep; on the median line just above the basal impression there is a circular tubercle. Scutellum small and triangular. Elytra entirely covering the abdomen, tips separately rounded, lateral margins and tips strongly serrate, surface coarsely and densely punctured, punctures near suture sparser and somewhat confused. Legs testaceous, femora toward tips and tibiæ near bases ringed with dark. Length, 3.5 millimeters.

Male.—Unknown.

Female.—Ventral segments apparently unmodified.

Type, a female from Kolambugan, Lanao Province, Mindanao (*Baker*).

Neohydnus tibialis sp. nov.

Black, slightly aëneous, each elytron with a circular patch of pale pubescence medianly and a smaller elongate patch of similar pubescence toward apex. Form parallel, somewhat depressed. Head very finely and sparsely punctured, with a few scattered pale hairs; antennæ about as long as greatest diameter of eye, with the fourth, sixth, and eighth segments larger than the fifth or seventh, the tenth and eleventh together broadly oval. Thorax broader than long (22–27), surface smooth except for a few scattered punctures, lateral dilations moderate, lateral foveæ double, deep and distinct, anterior transverse impression feeble, basal a well-defined groove. Scutellum small and inconspicuous. Elytra long, suture closed nearly to apex, lateral margins strongly serrate, tips separately rounded with a few teeth, surface moderately densely and coarsely punctured, pubescence as described above. Sides of mesosternum with a few very large punctures, metasternum very finely punctured and sparsely pubescent. Legs moderately thin and long, tibiæ and tarsi, together with the extreme tips of the femora, brown. Length, 3.6 millimeters.

Male.—Unknown.

Female.—Ventral segments apparently unmodified.

Type, a female from Baguio, Benguet Subprovince, Luzon (*Baker*).

Neohydnus constrictus sp. nov.

Black, each elytron at apical two-fifths with a central circular spot and an irregularly shaped spot near the lateral margin, of pale pubescence; apices also pubescent. Form elongate, head and thorax conspicuously narrow. Head sparsely punctured, surface rather closely covered with pale depressed pubescence, front rather narrow; antennæ short, stout, the segments from sixth on wider than usual, almost as wide as tenth and eleventh. Thorax as long as broad, though appearing at first glance to be elongate; surface rugose, disk with a short median longitudinal carina which crosses the anterior transverse impression, basal impression deep and distinct, lateral dilations feeble, lateral foveæ triple and distinct. Elytra very gradually and slightly widened behind, suture closed nearly to apex, lateral margins

and tips, which are rounded, serrate; surface coarsely and densely punctured, almost reticulate. Underparts black, mesosternum coarsely, metasternum finely punctured. Legs mostly pale, apical half of hind femora and basal half of hind tibiæ dark, all tarsi pale. Length, 3.7 millimeters.

Male.—Last dorsal and last visible ventral evenly rounded.

Female.—Unknown.

Type, a male from Mount Maquiling, Laguna Province, Luzon (*Baker 6074*).

Neohydnus auripilosus sp. nov.

Form elongate, subparallel. Color black, antennæ, mouth parts, and legs paler; elytra rather densely clothed with golden pile. Head very finely and rather densely punctured, thickly clothed with silvery depressed hairs; antennæ short, club oval, piceous. Thorax slightly broader than long (32–35), anterior transverse impression moderately distinct, lateral dilation moderate, lateral foveæ triple, basal impression deep and distinct, surface finely wrinkled, more especially so anteriorly, with fine punctures; pubescence sparse. Elytra long and narrow, densely and coarsely punctured, punctures disappearing toward apices, surface between punctures alutaceous, suture dehiscent toward tips, lateral margin and apices coarsely serrate. Underparts black and shining, finely punctured, legs uniformly pale. Length, 4 to 4.5 millimeters.

Male.—Last dorsal segment with truncated median lobe, last ventral broadly and not deeply emarginate.

Female.—Last ventral with a broad and shallow median longitudinal groove.

Type, a male from Basilan (*Baker*); paratype, a female from the same locality (*Baker*).

Neohydnus colon sp. nov.

Form elongate, parallel, width across apical third of elytra slightly less than at base or apex. Color black, except for antennæ, mouth parts, most of legs, and elytral spots, which are pale testaceous. Head finely alutaceous, punctures indistinct, frons with depressed silvery pubescence; antennæ short and stout, club oval. Thorax wider than long (28–31), surface shining but distinctly uneven; individual punctures very fine, almost obsolete; anterior transverse impression composed of a series of quadrate punctures instead of the usual continuous

groove; lateral dilations broad but not very prominent; greatest width at anterior third; lateral foveæ double, the usual posterior (third) fovea absent; basal transverse impression normal. Elytra dehiscent from apical third, lateral margins and apices coarsely serrate, punctures very coarse and closely placed, apices slightly tumid, pubescence pale, sparse, and erect. Each elytron with a single transversely oval pale spot at apical third. Underparts shining, very finely and sparsely punctured. Legs pale, the basal extremity of the posterior tibia infuscate. Length, 3 millimeters.

Male.—Terminal dorsal abdominal segment evenly rounded, last visible ventral slightly truncate.

Female.—Unknown.

Type, a male from Basilan (*Baker*).

Neohydnus sexnotatus sp. nov.

A large, compactly built, oblong species. Color black, antennæ, mouth parts, and legs piceous; each elytron with three large patches of golden pubescence. Head smooth and shining, very finely and sparsely punctured, sparsely pubescent; antennæ moderate in length, club oval. Thorax short and broad (40–52), anterior and basal transverse impressions deep and distinct, lateral foveæ triple, surface except on disk coarsely wrinkled, disk smooth and polished with few punctures; pubescence sparse and erect. Elytra long and parallel, suture closed almost to tips, lateral margins and apices coarsely serrate, surface coarsely and densely punctured, alutaceous between punctures; each elytron with patches of golden pubescence as follows: The first patch is basal and is somewhat rectangular; the second, median and transversely oval; the third, apical, elongate-oval, its major axis lying with the longitudinal axis of the elytron. Underparts shining, finely and sparsely punctured. Legs piceous, the posterior femora in part darker. Length, 5 millimeters.

Male.—Unknown.

Female.—Terminal segments of abdomen simple, not modified.

Type, a female from Dapitan, Zamboanga Province, Mindanao (*Baker*).

Neohydnus scutellatus sp. nov.

Form elongate-oblong, parallel. Color black except for antennæ, mouth parts, apices of tibiæ and tarsi, which are pale; scutellum, median and subapical bars on elytra densely covered with silvery hairs. Head shining, almost impunctate, pubes-

cence sparse; antennæ rather short, club oval. Thorax broader than long (22–33), surface coarsely wrinkled, anterior and basal impressions distinct, lateral foveæ double, almost coalescing, lateral dilations rather prominent. Scutellum large and triangular, densely clothed with silvery pubescence. Elytra parallel, lateral margins and apices very feebly serrate, coarsely and not confluently punctured, surface between punctures finely alutaceous; at the middle of the length there is a transverse, curved bar of silvery hairs with the convexity directed anteriorly, and a similar bar with the convexity directed posteriorly is placed just before the apex. Underparts and legs (except for the extreme tips of tibiæ and tarsi) black. Length, 3 millimeters.

Male.—Unknown.

Female.—Terminal segments of abdomen unmodified.

Type, a freshly emerged female, somewhat distorted, from Basilan (*Baker*).

Neohydnus pilosus sp. nov.

Form oblong, parallel. Color black, antennæ, mouth parts, and legs pale. Head almost impunctate, sparsely covered with fine depressed aureous pubescence; antennæ moderate in length, club obconical, rounded at extremity. Thorax almost equilateral (21–22), lateral dilations weak; anterior transverse impression shallow, poorly defined, basal impression well defined, angulate at middle; lateral foveæ double, well defined, surface finely and closely punctured, well covered with depressed aureous pubescence and with a few upright pale hairs. Elytra coarsely and rather closely punctured, suture strongly beaded and closed almost to apex, evenly and sparsely set with upright pale hairs and with depressed aureous pubescence in patches, as follows: Subbasally there is a roundish patch of indefinite extent; slightly postmedian there is a V-shaped patch, the upper extremities of the V touching, respectively, the lateral and sutural margins and with the sutural half of the design much more heavily developed than the other; behind the V there is a very slight break and the pubescence is resumed and extends to the apex; in the apical fourth the pubescence is confined to the margins, leaving an irregular central spot bare; the lateral margins and apices of the elytra are serrate. Underparts black, legs (with the exception of the basal half of hind tibiæ, which is infuscate) pale. Length, 3 to 4 millimeters.

Male.—Unknown.

Female.—Terminal abdominal segments unmodified.

Type, a female from Mount Limay, Bataan Province, Luzon (*Baker*); paratypes, two females from the same locality.

Genus **BRACHYCALLIMERUS** novum

Callimerus (pars) of authors.

Generic characters.—Hydnocerinæ, with the first tarsal segment longer than the second. Head broad; eyes very prominent, very slightly emarginate near antennal socket; labrum entire, mandibles broad and flat, falcate, with sharp tooth internally near apex; antennæ short and compact, eleven-segmented, first segment short and stout, second nearly spherical, third to sixth longer than broad, seventh to eleventh broader than long, each wider than the preceding, together forming a compact obtriangular five-segmented club. Thorax broader than long, polished, with a few distinct punctures. Elytra broader at base than thorax, punctures not in rows, numerous. Upper surface of entire insect devoid of scales. Abdomen with six visible ventral segments, secondary sexual modifications of male conspicuous. Legs moderate in length, posterior tibiæ with subapical notch, tarsi short, tarsal claws broadly toothed at base.

Genotype, *Callimerus latifrons* Gorh., 1876.

Geographical range, Indo-Malaysia.

The insects which I include in this new genus have heretofore been classified with the species of *Callimerus* Gorh. They differ from those species in their broad and compact form, short and compact antennæ, and the total absence of scales from the upper surface. In addition to the genotype, I would include the following species: *latesignatus* Gorh., *rusticus* Gorh., *pectoralis* Schklg., and probably *trifasciatus* Schklg.

Brachycallimerus latifrons (Gorham). Plate 1, fig. 8; Plate 3, fig. 28; Plate 4, fig. 46.

Callimerus latifrons GORHAM, Cist. Ent. 2 (1876) (1875–1882) 67.
Callimerus flavofasciatus SCHENKLING, Bull. Mus. Hist. Nat. Paris 8 (1902) 319.

Form short and broad, somewhat depressed. Color black, elytra with yellow markings, legs entirely yellow. Head finely and closely punctured, frons thickly clothed with short white hairs; antennæ with the first, second, and eighth to eleventh segments pale, the rest piceous. Thorax broader than long, (33–36), punctures sparse on disk, slightly denser at sides; anterior and basal transverse impressions well defined; lateral

dilations almost hemispherical; lateral foveæ single, almost obsolete. Elytra with punctures coarse and well separated, without definite arrangement, suture beaded, apices internally truncate, tips each with small mucro; color black with basal fourth, a transverse postmedian band, and an apical spot flavous. Underparts of thorax black except for the median portion of the mesothorax, which is pale. Abdomen piceous. Legs rather stout, pale; hind tibiæ with subapical notch. Length, 9 millimeters.

Male.—Fifth abdominal sternite with broad, shallow, and evenly curved emargination; sixth similar but with the emargination proportionally deeper. Terminal dorsal evenly rounded.

Female.—Unknown.

MINDANAO, Davao Province, Davao: Zamboanga Province, Dapitan. BASILAN (*Baker 4271*). SUMATRA, Medan (*Corporaal*). Siam.

The type locality of Gorham's name is "E. Mindanao." Schenkling described *flavofasciatus* from Siam and stated in the original description that the species differs from *latifrons* Gorh. in having a subapical spot. This spot is mentioned in Gorham's original description and all specimens before me have it. For this reason I have considered the two species synonymous.

Genus **CALLIMERUS** Gorham

Callimerus GORHAM, Cist. Ent. 2 (1876) (1875–1882) 65; SCHENKLING, Gen. Ins. (Wytsman) Cleridae, Fasc. 13 (1903) 24; GAHAN, Ann. & Mag. Nat. Hist. VIII 5 (1910) 61.

Caloclerus KUWERT, Ann. Soc. Ent. Belg. 37 (1893) 480; SCHENKLING, Ann. Soc. Ent. Belg. 45 (1901) 105.

Generic characters.—Hydnocerinæ, with the first tarsal segment longer than the second. Head vertical; labrum entire; mandibles stout, falcate, with internal tooth near apex; terminal segment of maxillary palp twice as long as preceding segment, subulate; that of labial palp elongate-triangular; antennæ moderately long, slender, distinctly eleven-segmented, first segment stout, bent, at least twice the length of the second, which is from nearly as long as broad to equilateral and globular, third to eighth much longer than broad, each segment shorter than the preceding, ninth to eleventh forming a lax, oval club, eleventh oval at tip; eyes finely granulate, prominent, very slightly

emarginate at base of antennæ. Thorax longer than broad, somewhat constricted before and behind, moderately to strongly dilated at or before the middle, anterior coxal cavities very widely open behind. Elytra entirely covering the abdomen, long, narrow, sides parallel, adorned with white or yellow scales, these scales often forming a definite pattern. Abdomen with six visible ventral segments; in the male the terminal segments are often profoundly modified; in the female the modification, if any, occurs on the penultimate segment. Legs rather long, posterior tibiæ with or without a notch with comb of hairs near its apex; tarsi moderately long, five-segmented, the basal segment the longest, claws almost simple or with broad basal platelike tooth.

Genotype, *Clerus* (*Xylobius*) *dulcis* Westw., by orignal designation of Gorham.

Geographic range, Indo-Malaysia.

The type species, *Callimerus dulcis* (Westw.), has been reported from the Philippine Islands but is probably not found there under normal conditions. Material from Assam fits the original description and figure perfectly and, in view of the very local distribution of the other species of the genus, this is probably very near to the type locality. The locality "Java" as given in the original paper is probably a result of the lax system of labeling material in vogue eighty years ago. However, for convenience, the species is included in the key, though not treated further. There are now seventeen species known to inhabit the islands of the Philippine group, which may be distinguished by means of the following key:

Key to Philippine species of Callimerus Gorham.

1. Hind tibiæ with subapical notch. (Section A.) .... 2.
   Hind tibiæ without subapical notch. (Section B.) .... 9.
2. Upper surface dark blue or black, with markings of white scales; tarsal claws with prominent basal tooth .... 3.
   Upper surface not entirely dark blue or black; thorax always testaceous or grass green; tarsal claws nearly simple .... 5.
3. Each elytron with three denuded areas along the outer margin and with an elongate lozenge-shaped spot at the middle on the suture; thorax with median and lateral denuded areas .... C. princeps Chapin.
   Each elytron with a number of roundish spots of white scales .... 4.
4. Each elytron with four spots .... C. octopunctatus Heller.
   Each elytron with seven spots .... C. dulcis (Westwood).
5. Puncture rows 4, 5, and 6 (from suture) not conspicuously crowded; elytra evenly covered with scales .... 6.

Puncture rows 4, 5, and 6 close together, the included surface devoid of scales, producing a striped appearance........ 7.

6. Parapenes greatly swollen behind the terminal hooks; lateral lobes of terminal abdominal tergite (male) twice as long as width at apex. **C. luzonicus** Chapin.

Parapenes not swollen behind the terminal hooks; lateral lobes three times as long as width at apex........ **C. bakeri** Chapin.

7. Scales on elytra clear white; terminal tergite of male with median process small, not more than one-fifth as long as lateral rami; lateral rami rounded at tips........ **C. basilanicus** Chapin.

Scales on elytra yellow........ 8.

8. Median process of terminal tergite of male short, about half as long as lateral rami; lateral rami subacute at tips; elytra without denuded stripe........ **C. intermedius** sp. nov.

Median process of terminal tergite of male long, nearly as long as lateral rami; lateral rami rounded at tips; elytra with denuded stripe. **C. lateralis** Chapin.

9. Elytra blue or blue-black, with linear markings of white scales........ 10.

Elytra not with linear markings of white scales, if so, then not blue or blue-black........ 11.

10. Denuded areas of elytra as follows: Two at base, followed by two incompletely inclosed large lateral areas, the suture being very narrowly bare; lateral areas connected across suture at apical part. **C. gratiosus** Gorham.

Denuded areas of elytra, two at base, followed by three more or less completely inclosed equal rectangular areas, the median rectangle common to both elytra........ **C. fenestratus** Chapin.

11. Elytra dark blue or black, almost entirely covered with white scales.. 12.

Elytra brown or testaceous, scales sometimes forming definite lines.. 15.

12. Species small (5.5 millimeters); vestiture of scales very dense, insect appearing snow-white except for four small round spots, a pair at middle and a pair beyond apical fourth; legs pale yellow. **C. albus** Chapin.

Species large (8 millimeters); vestiture of scales not very dense, insect appearing gray, three or more spots on each elytron, these not well defined........ 13.

13. Each elytron with eight spots as follows: One humeral; a pair at basal fourth; a fourth small, median; a pair larger, slightly postmedian; a single one at apical fifth similar in size to last; and a small subapical spot........ **C. bisoctonotatus** sp. nov.

Each elytron with three spots, one basal, one median, and one subapical........ 14.

14. Male with sixth abdominal sternite emarginate at apex, the emargination broad and shallow, evenly curved........ **C. persimilis** Chapin.

Male with the sixth sternite bilobed, the emargination between the lobes V-shaped........ **C. albescens** Chapin.

15. Denuded areas on elytra reduced to isolated spots or absent........ 16.

Elytral pattern composed of scaled areas, each separated from its neighbors by denuded lines forming an incomplete network, suture nude........ 17.

16. Thorax and elytra entirely covered with scales; however, some portions of elytra are more densely scaled than others, producing the effect of a yellow pattern on a yellowish brown background. **C. flavus** Chapin.
  Denuded areas poorly defined but distinctly present; thorax with three discal denuded areas .... **C. pulchellus** Gorham.
17. Scales on each elytron clearly separated into three distinct patches, one on basal half, one on apical half, and one small semicircular spot at middle near suture, which forms with the corresponding spot on the other elytron a nearly circular spot .... **C. schultzei** Schenkling.
  Scales on each elytron not divided into completely isolated patches, subsutural line of scales being unbroken throughout its length, scales on posterior half forming the conventional "trefoil" pattern. **C. trifoliatus** sp. nov.

Callimerus princeps Chapin. Plate 4, fig. 29; Plate 5, fig. 50.

Callimerus princeps CHAPIN, Proc. Biol. Soc. Wash. 32 (1919) 227.

Elongate, parallel; black, legs, antennæ, and mouth parts pale, more or less covered with glossy white scales. Head finely and very minutely punctured, entirely covered with scales except for the vertex and a narrow line running down onto the frons. Thorax longer than wide, dilated at the middle, broadly and shallowly impressed at the apex, narrowly and more deeply at the base; a triangular median spot, and the lateral portions are free from scales. Elytra parallel, black, deeply and coarsely punctured except along the suture at the median third of the length; surface of elytra between the punctures dull alutaceous; there are seven denuded areas, one subbasal on each elytron, one median lateral on each elytron and one median central common to the two elytra, and one subapical on each; the apices of the elytra are internally obliquely truncate, the outer angle only mucronate. Underparts black, laterally densely covered with white scales. Legs pale testaceous, the femora showing traces of green pigment; posterior tibiæ with subapical notch. The entire surface of the beetle has, in addition to the scales, a vestiture of long, erect hairs, rather sparsely placed. Length, 7 millimeters.

Male.—Terminal abdominal tergite dilated and bifurcate. Each ramus extends outward and downward, becoming gradually widened to the tip, which is sharply truncate. The tips of the rami are turned under toward the median line. Between the rami there is a small triangular projection.

Female.—Fifth sternite with a lobe on either side of the median line, each lobe as long as broad and truncate. The truncature carries a row of about eight bristles. Sixth ventral simple and unmodified.

Type, a male from Basilan (*Baker 11534*). Other specimens from Basilan (*Baker 11878*), and a female from Iligan, Lanao Province, Mindanao (*Baker*).

Callimerus octopunctatus Heller. Plate 4, fig. 41.

Callimerus octopunctatus HELLER, Philip. Journ. Sci. 19 (1921) 532, pl. 1, fig. 5.

Form elongate, parallel. Color deep bluish black, antennæ and legs yellowish; each elytron with four spots. Head shining, finely and sparsely punctured, sparsely pubescent; antennæ rather short, as long as the longest diameter of eye. Thorax longer than wide, coarsely and sparsely punctured; with four spots of white scales, one spot at each corner of the disk, surface shining between punctures. Elytra long, parallel, tips obliquely truncate; angles not distinctly mucronate, surface coarsely and irregularly punctured, not shining between punctures; each elytron with four irregularly shaped spots of white scales, one basal, a second at basal fourth, a third just behind middle, and a fourth near the apex. Underparts shining, finely punctured, lateral portions densely clothed with white scales. Legs pale yellow-brown, posterior tibiæ with subapical notch. Length, 8 to 10.5 millimeters.

Male.—Unknown.

Female.—Terminal abdominal segments simple, unmodified.

Type from Mount Maquiling, Laguna Province, Luzon.

This species was described by Heller from material received from Baker. Heller compares the species with *C. pictus* Gorham. It appears to me to be more nearly related to *C. decoratus* Gorham. Through the kindness of Dr. Karl Jordan, of the Tring Museum, I have received a specimen of *C. decoratus* from Momeit, Burma, altitude 2,000 feet. The arrangement of the spots is different in the two species, the basal spots of *C. decoratus* being placed at a considerable distance from the base. The tibiæ of *C. decoratus* are darker, especially the posterior pair.

Professor Baker has sent to me this or a very close relative from Surigao and Dapitan, Mindanao (*Baker 12737*). Lacking material from Luzon I am unable to state definitely that they are the same.

Callimerus luzonicus Chapin. Plate 5, fig. 48.

Callimerus luzonicus CHAPIN, Proc. Biol. Soc. Wash. 32 (1919) 230.

Elongate; head and thorax dark testaceous, the latter usually distinctly greenish, elytra varying from piceous to rufotesta-

ceous. Head shining, almost impunctate, with a few white scales near the eyes. Thorax not strongly dilated but with distinct anterior and basal transverse impressions; lateral foveæ distinct, circular; entire surface devoid of scales, though distinctly pubescent. Elytra long, parallel, piceous with the extreme base rufous to rufotestaceous with the lateral margins and tips piceous, evenly covered with white scales; punctures moderate in size, distinctly in rows, the rows spaced more or less evenly from the suture to the side margin; tips internally obliquely truncate, the outer angle with mucro, the inner broadly rounded. Underparts as usual with the lateral parts densely scaly. Legs pale with greenish tinge; posterior tibiæ with subapical notch. Length, 7 to 8.5 millimeters.

Male.—Terminal abdominal tergite very broad and deeply cut out so that the lateral horns are very slender. These horns are bent under and are widened into hooked chisel-like blades. The center portion of the segment is slightly produced and broadly rounded.

Female.—Fifth sternite very broadly and shallowly emarginate, the emargination commencing near the lateral margin. Sixth sternite simple, unmodified.

Type, a male from Mount Maquiling, Laguna Province, Luzon, (*Baker 11546*) ; paratypes, males and females, Mount Maquiling, (*Baker 1655, 1656, 11546*).

Callimerus bakeri Chapin. Plate 5, fig. 47.

Callimerus bakeri CHAPIN, Proc. Biol. Soc. Wash. 35 (1922) 134.

Form, size, and superficial appearance much as in *C. luzonicus* Chpn. Frontal region including clypeus rather densely punctured, occiput and vertex smooth and shining. Eyes margined in front with white scales, which are continued in a band across the punctured portion of the front. Thorax urn-shaped, the basal transverse impression bordered behind by a sharply raised ridge, anterior impression broad and shallow, with numerous very fine transverse striæ, especially toward the middle; lateral dilations moderate, lateral foveæ broad, circular, and shallow; punctures fine and sparse. Scutellum truncate behind. Elytra long, lateral margins almost parallel, apices obliquely truncate, the outer angle of the truncature with a rather conspicuous mucro; punctures rather fine, arranged in longitudinal rows, the rows becoming closer together as the lateral margin is approached but without the conspicuous crowding of rows 4 to 6 as in *C. lateralis* Chpn.; scales yellowish white, evenly

distributed over the elytral surface; the flanks of the elytra are slightly darker than the disk. Underparts heavily scaled along the sides, abdominal sternites moderately closely punctured.

Male.—Terminal tergite with a broad median triangular lobe which is subacute at apex. Laterally, the segment is prolonged into a thin, flat ramus on each side, which ends in an upwardly directed thornlike triangular process. The lobes of the penis sheath end in short, outwardly directed hooks. Fifth and sixth sternites transverse, nearly straight. Length, 6.5 millimeters.

Female.—Fifth sternite with a very broad and shallow emargination, the width of the emargination about equal to one-half the width of the sclerite. Length, 8 millimeters.

Type, a male from Butuan, Agusan Province, Mindanao (*Baker 17541*). Paratypes from Mindanao, as follows: A female from Surigao, Surigao Province (*Baker 14726*); a female from Iligan, Lanao Province (*Baker 12736*), and 4 males and 3 females from Surigao, Surigao Province (*Baker*); 3 females from Butuan, Agusan Province. Type in my collection; paratypes in collections of Baker and myself.

Callimerus basilanicus Chapin. Plate 4, fig. 40; Plate 5, fig. 52.

Callimerus basilanicus CHAPIN, Proc. Biol. Soc. Wash. 32 (1919) 231.

Similar in size and form to *C. lateralis*. Head shining, finely and sparsely punctured, the epistoma, frons, and region about the eyes thickly covered with white scales. Thorax greenish, dilated at the sides, anterior constriction shallow, posterior deep, well defined; lateral depressions round, shallow but distinct; surface with a few fine punctures and in the vicinity of the lateral depressions with fine wrinkles; along the sides of the disk there are a few white scales. Elytra black, punctures definitely in rows as in *C. lateralis*, well covered with scales except for the following: On each elytron near the base a rectangular patch which is continued as a fine line along the second row of punctures; the suture; the intervals between the fourth, fifth, and sixth rows almost to the apex where there is a second patch; the interval between the seventh and eighth rows, and this stripe joins the preceding at the humerus and at the apical rectangular patch; the apices are hardly truncate, but there is a mucro at the middle of each apical margin. Underparts as in the preceding species. Legs pale, femora greenish; posterior tibiæ with subapical notch. Length, 6.5 millimeters.

Male.—Terminal abdominal tergite very broad, very broadly and shallowly emarginate, the lateral portions revolute. There

is a slight trace of a third ramus in the form of a minute triangular projection at the middle of the emargination.

Female.—Unknown.

Type, a male from Basilan (*Baker 11529*).

Callimerus intermedius sp. nov. Plate 5, fig. 51.

Form and size of *C. basilanicus* Chpn. but with differently colored scales and with male genitalia somewhat between that species and *C. lateralis* Chpn. Head finely and rather densely punctured on clypeal region and occiput, smooth and shining on frons and vertex; color of head, antennæ, and trophi rufotestaceous, tips of the mandibles dark, front sparsely scaled, eyes in front bordered with scales. Thorax much as in *C. bakeri* Chpn., but with lateral dilations a bit more prominent and with the anterior transverse impression with fewer and coarser striæ; color grass green, the pigment not very evenly distributed and apparently on the undersurface of the chitin. Scutellum with a small shallow notch behind. Elytra long and narrow, sides slightly convergent behind, apices internally obliquely truncate, angles of truncature without mucrones. Striæ 4 to 6 (from suture) crowded. Scales evenly distributed over entire surface, interspaces 5 and 6 not nude. Underparts rather densely and finely punctured, flanks heavily scaled. Legs mostly grass green, hind tibiæ with subapical notch. Length, 6.7 millimeters.

Male.—Terminal abdominal tergite trilobed, the median lobe almost an equilateral triangle, the lateral lobes about twice as long and subacute at tips. Fifth sternite broadly and shallowly emarginate. Sixth sternite bilobed, the notch between the lobes twice as wide as deep.

Female.—Unknown.

Type, a male from Surigao, Surigao Province, Mindanao (*Baker*).

Callimerus lateralis Chapin. Plate 1, fig. 7; Plate 3, fig. 25; Plate 4, fig. 42; Plate 5, fig. 49.

Callimerus lateralis CHAPIN, Proc. Biol. Soc. Wash. 32 (1919) 230.

Similar in form and appearance to *C. luzonicus*. Head smooth, shining, sparsely and moderately finely punctured. Thorax somewhat dilated, anterior and posterior depressions distinct; punctuation moderately coarse and sparse, the entire thorax free from scales; in the type the thorax is deeply suffused with green, traces of which appear in some of the other specimens. Elytra

long, narrowed toward the tips; punctures in rows, the fourth, fifth, and sixth rows close together, taking up space equal to the interval between the first and second; surface densely and evenly covered with yellowish white scales except for the interval between the fourth and sixth rows of punctures; tips of elytra truncate, slightly obliquely, neither angle with mucro. Underparts shining and finely punctured, densely clothed with scales along the sides. Legs pale, femora quite greenish; posterior tibiæ with subapical notch. Length, 6 to 8 millimeters.

Male.—Terminal abdominal tergite broad and trifurcate, the three prolongations triangular and nearly of even length.

Female.—Fifth sternite much as in *C. princeps*, but lobes longer proportionally and with a fringe of more and finer hairs. Sixth sternite unmodified.

Type, a male from Basilan (*Baker 11530*). Paratypes: A female from Basilan (same data as type); two males from Zamboanga, Zamboanga Province, Mindanao (*Baker 7279*); a male from Dapitan, Zamboanga Province, Mindanao (*Baker 11547*); a female from Iligan, Lanao Province, Mindanao (*Baker 6077*); and a female from Davao, Davao Province, Mindanao; other specimens from Basilan (*Baker 11876*), Dapitan (*Baker 14728*), Kolambugan, Lanao Province (*Baker 14730*), and Butuan (*Baker*).

Callimerus gratiosus Gorham. Plate 4, fig. 34; Plate 5, fig. 58.

Callimerus gratiosus GORHAM, Cist. Ent. 2 (1876) (1875–1882) 66.

Oblong, parallel. Head with fine and coarse punctures intermingled, frons densely clothed with white scales; antennæ and mouth parts, except for tips of mandibles, pale. Thorax sparsely set with coarse round punctures, longer than broad (28–25), somewhat constricted before and behind the lateral dilations which are rather feeble; there are broad basal and apical transverse bands of white scales, these bands broken slightly on the disk. Elytra deep violet-blue, each with six patches of white scales; the first spot partly surrounds the humeral callus, the second is small, on the suture directly behind the densely scaled scutellum, the third is transversely oblong, reaching the lateral margin but failing the suture, the fourth is small, nearly circular, close to the sutural end of the third and almost joins it, the fifth is arcuate, postmedian, almost attaining both suture and lateral margin, its convexity directed forward, the sixth is subapical, nearly oblong, with the internal basal angle continued a short distance along suture; punc-

tures of elytra very large and crowded, those at the middle of the length polygonal in shape; apices truncate with small mucro on external angle of truncature. Underparts shining, finely punctured, laterally covered with scales. Legs pale, the posterior femora and tibiæ with darker patches; fifth segment of all tarsi darker; posterior tibiæ without apical notch. Length, 8 millimeters.

Male.—Terminal tergite with a shallow notch at its extremity. Sixth sternite deeply triangularly emarginate. Valves of penis sheath acutely triangular in lateral view.

Female.—Fifth sternite very slightly emarginate, sixth simple.

This species was described by Gorham from specimens collected by Semper in "East Mindanao." I have seen specimens from Zamboanga, Zamboanga Province, Mindanao (*Baker 7281*); Butuan, Agusan Province, Mindanao (*Baker 17589*); and Basilan (*Baker 11879*).

Callimerus fenestratus Chapin. Plate 4, fig. 31; Plate 5, fig. 53.

Callimerus fenestratus CHAPIN, Proc. Biol. Soc. Wash. 32 (1919) 232; HELLER, Philip. Journ. Sci. 19 (1921) 532, pl. 1, fig. 4.

Elongate, parallel; blue, decorated with lines of white scales, antennæ and legs pale. Head sparsely and distinctly punctured, except for a smooth space on vertex; frons and epistoma densely clothed with white scales. Thorax hardly dilated at sides, the anterior constriction very feeble, the posterior more sharply defined, submarginal; sides of front densely covered with scales as is the entire base; the nude part behind anterior constriction very coarsely and sparsely punctured, and shiny between the punctures; in front of anterior constriction the surface is transversely wrinkled and minutely punctured. Elytra parallel almost to tip where they are suddenly narrowed; punctuation very coarse, moderately dense; surface between the punctures alutaceous; color blue with white scales as follows: Four transverse bands, one basal, a second at basal fourth, the third at apical two-fifths, and the last subapical; these bands are connected, one to another, by longitudinal stripes, the first to the second by the suture, the second to the third by two, one on each elytron about halfway between suture and margin, and the third to the fourth by the suture, the sutural angles in all cases rounded; tips remotely subtruncate, without mucro. Underparts very dark piceous, laterally with scales. Legs pale

testaceous, each tibia with a darker stripe; posterior tibiæ without subapical notch. Length, 6.5 millimeters.

Male.—Terminal tergite simple, rounded, not perceptibly widened, very slightly emarginate at tip.

Female.—Unknown.

Type, a male from Puerto Princesa, Palawan (*Baker 4272*).

Callimerus albus Chapin. Plate 4, fig. 36.

Callimerus albus CHAPIN, Proc. Biol. Soc. Wash. 32 (1919) 233.

Elongate, parallel; black, almost entirely covered with white scales. Head so densely clothed with scales that the surface is entirely concealed; eyes black, very conspicuous; antennæ and mouth parts pale testaceous. Thorax somewhat dilated at sides, entirely covered with scales. Elytra black, coarsely and sparsely punctured, at least where the punctures show; entirely and very densely covered with snow-white scales except for four small roundish spots, two median lateral and two subapical; tips of elytra internally obliquely truncate, the outer angle mucronate. Underparts as usual. Legs pale testaceous, posteterior tibiæ without subapical notch. Length, 5.5 millimeters.

Male.—Terminal abdominal tergite entire, somewhat dilated, fringed with rather long hairs. The median part is prolonged, perhaps, a slight distance beyond the lateral portions.

Female.—Unknown.

Type, a male from Basilan (*Baker 11520*).

Callimerus bisoctonotatus sp. nov. Plate 4, fig. 44.

Form and size of *albescens* Chapin, to which it is related. Color black except for epistomal region, trophi, antennæ, and legs, which are pale. Body above almost covered with white scales, leaving on the thorax a median line and spot, and on each elytron leaving eight scaleless spots. Head, especially on frons, very densely covered with white scales, so far as can be ascertained, sparsely and finely punctured; antennæ long, the terminal three segments more elongate than usual. Thorax longer than broad (54–43), anterior half transversely striate, with a few coarse punctures, the median line in basal half smooth, impunctate, anterior transverse impression feeble, basal impression deep, distinct, and angulate at median line, the apex of the angle directed cephalad; lateral dilations moderately prominent. Elytra with lateral margins almost parallel, apices internally obliquely truncate, outer angle mucronate; punctures

coarse and moderately closely placed, not forming definite lines; suture with very narrow bead; scales dense, the following spots nude: A humeral spot including the humeral callus and extending a short distance obliquely toward the suture and directed posteriorly, at basal fourth two of these, the marginal spot triangular, its base parallel to margin and altitude less than half the base, and the sutural spot oval, its long axis running parallel to the long axis of the elytron; at just before the middle is a small transverse oval spot, about halfway between suture and margin; slightly postmedian are two large, almost round spots, nearly joined, the outer spot the larger; at apical fifth is a rectangular spot reaching from the lateral margin to about the middle of the width of the elytron; lastly, there is a small subapical, nearly round spot. Underparts finely and densely punctured, flanks thickly clothed with white scales. Posterior tibia without subapical notch. Length, 7 millimeters.

Male.—Terminal abdominal tergite evenly rounded, fringed with long hairs. Fifth sternite straight, the lateral posterior angles slightly produced. Sixth sternite with a deep broadly triangular emargination, the width of the emargination about half total width of segment.

Female.—Unknown.

Type, a male from Butuan, Agusan Province, Mindanao (*Baker 17590*).

Callimerus persimilis Chapin. Plate 5, fig. 56.

Callimerus persimilis CHAPIN, Proc. Biol. Soc. Wash. **35** (1922) 133.

General appearance, form, and size as in *C. albescens* Chapin, from which the present species differs markedly in the genital characters. Black, almost entirely clothed above with white scales; legs, antennæ, mouth parts, and sometimes abdomen pale. Head, except for the labrum and underside, very densely clothed with scales, finely alutaceous above, smooth beneath, antennal club very lax, terminal segment oval. Thorax almost cylindrical; apical and basal transverse impressions broad and shallow; lateral dilations feeble, the width at extreme base being almost equal to the width across them; on the disk is a shallow depressed area followed by a smooth median line which reaches to the basal marginal bead; surface, except on the smooth line, with coarse, scattered punctures. Elytra with the punctures of basal half arranged in rows; these rows fail entirely beyond

apical fourth; surface as it appears at the nude spots finely alutaceous, almost entirely covered with white scales, the scales being absent at almost the same places as in *C. albescens*. Underparts finely wrinkled, laterally with white scales. In one specimen, a female, the abdomen is pale. Legs long and slender, claws with small basal lobe, almost simple; hind tibia without subapical notch. Length, 6.5 to 7.5 millimeters.

Male.—Fifth abdominal sternite with a broad and shallow emargination, sixth sternite similar to fifth, terminal tergite evenly rounded, lobes of penis sheath with external hooklike processes on external side.

Female.—All sternites with simple, unmodified margins.

Type, a male from Surigao, Surigao Province, Mindanao (*Baker 16293*). Paratypes, one male and two females from Surigao (*Baker 14725*) and one female from Kolambugan, Lanao Province, Mindanao (*Baker*).

Callimerus albescens Chapin. Plate 4, fig. 45; Plate 5, fig. 55.

Callimerus albescens CHAPIN, Proc. Biol. Soc. Wash. 32 (1919) 232.

Elongate, parallel; black, almost evenly but sparsely covered with scales; legs paler. Head black, without visible punctures, evenly and sparsely clothed with scales, these slightly denser near the eyes; mouth parts and antennæ pale testaceous. Thorax with sides slightly dilated, with a depression just before the middle of the base, apical transverse impression obsolete, sides with lateral depressions; surface evenly and sparsely scaly. Elytra parallel, closed, narrowed toward tips, coarsely punctured and strongly alutaceous, almost reticulate; sparsely clothed with scales except for the humeri and a median and subapical spot on each; tips internally obliquely truncate, neither angle mucronate. Underparts of thorax black, finely punctured, the lateral portions densely scaly. Abdomen pale brown, with dense covering of scales along sides. Legs brownish testaceous, posterior tibiæ with hardly a trace of subapical notch. Length, 8 millimeters.

Male.—Sixth sternite bilobed, each lobe almost semicircular, valves of penis sheath curved at tips and ending in small knobs. Tip of penis directed posteriorly and ending in a round knob.

Female.—All abdominal sternites simple, unmodified.

Type, a female from Zamboanga, Zamboanga Province, Mindanao (*Baker 6696*); also a male from Davao, Davao Province, Mindanao (*Baker*).

Callimerus flavus Chapin. Plate 4, fig. 35; Plate 5, fig. 57.

Callimerus flavus CHAPIN, Proc. Biol. Soc. Wash. 32 (1919) 233.

Rather small and slender, parallel. Head densely covered with yellowish scales, so that the sculpture is completely obscured; antennæ and mouth parts, except for tips of mandibles, pale; antennal club rather longer than usual. Thorax longer than wide, sides parallel before and behind lateral dilation which is slight; surface with a few large round punctures, evenly and densely clothed with yellowish scales. Elytra almost entirely covered with scales but certain portions (as shown in the figure) more densely clothed than the rest, so that the insect appears to have a yellowish pattern on a yellowish brown base; punctures of elytra, so far as they are visible, large and tending to form rows; apices rounded, neither truncate nor mucronate. Lateral portions of underparts densely clothed with white scales. Legs pale, posterior tibiæ without subapical notch or comb.

Male.—Terminal abdominal tergite entire, rounded, very slightly wider than ventral, fringed with long hairs. Sixth sternite narrow, bilobed, the emargination triangular and rather shallow. Valves of penis sheath slender and straight.

Female.—Unknown. The female specimen mentioned in the original description of this species proves on further examination to be a male. The abdomen is completely collapsed and partially telescoped.

Type, a male from Mount Banahao, Luzon (*Baker 7278*); paratype, a male from the same locality (*Baker 8290*).

Callimerus pulchellus Gorham. Plate 4, fig. 38; Plate 5, fig. 54.

Callimerus pulchellus GORHAM, Cist. Ent. 2 (1876) (1875–1882) 67.

Form oblong; color brown to black, rather densely covered with white scales, antennæ, mouth parts, and legs pale. Head brown, alutaceous, with a few large punctures, thickly clothed with white scales above the clypeus; clypeus with a few scales at base; antennæ rather long, club lax. Thorax with rather prominent lateral dilations, anterior transverse impression well marked at sides, less so on disk; basal impression very deep and distinct on disk; basal marginal bead broad and well elevated; surface finely wrinkled, the disk with a smooth area on basal half; there are also two smooth areas outside of this, the intermediate space filled with coarse punctures which are resumed again on the flanks; the punctured areas bear white scales. Elytra tapering slightly toward apex, suture closed, tips internally obliquely truncate, angles rounded, not mucronate; each

elytron with six denuded areas, as follows: A spot on the humeral callus and a subscutellar spot, which sometimes coalesce; a pair of spots at basal third, in a line at right angles to the suture the outer spot the smaller; behind these are two, the first submarginal at apical two-fifths, the second in apical fourth, more or less like a J with the hook toward the margin. The margin and suture are narrowly nude. Surface alutaceous with rather large and somewhat regularly spaced punctures. Underparts brown to black, finely wrinkled and punctured, lateral margins with white scales. Legs long and slender. Length, 7 to 8 millimeters.

Male.—Fifth sternite very deeply and broadly, arcuately emarginate; sixth with semicircular emargination occupying the middle third of the width; parapenes straight, obliquely truncate at tips. Terminal tergite subtruncate.

Female.—Fifth sternite with a median V emargination.

Surigao, Mindanao (*Baker 14727, 16294*), Butuan, Mindanao (*Baker 4273*).

The species was described from eastern Mindanao, hence the above localities very nearly coincide with the type locality.

Callimerus schultzei Schenkling. Plate 4, fig. 33.

Callimerus schultzei SCHENKLING, Philip. Journ. Sci. § D **8** (1913) 303.

Form moderately elongate and convex. Brown, with white scales. Head shining, very feebly wrinkled and with a few fine punctures, near eyes rather thickly clothed with white scales; antennæ testaceous, the basal segment darker, club very feebly formed, all segments longer than broad; mouth parts castaneous. Thorax almost cylindrical, anterior transverse impression broad and shallow, almost obsolete, disk with a few coarse punctures, its anterior half with fine transverse wrinkles, lateral dilations feeble, lateral foveæ obsolete, lateral portions clothed with white scales, these absent from the lateral dilations and discal stripe, basal marginal bead broad and well elevated. Elytra with moderately coarse punctures, the surface between the punctures alutaceous, suture closed, tips obliquely internally truncate, not mucronate; surface entirely covered with scales except for the sutural bead and lateral margins, a spot on each commencing at the humeral callus and running posteriorly nearly to basal fourth where it turns and runs at right angles nearly to suture; at the middle and common to both elytra is a diamond-shaped figure inclosing a spot of scales, its apices lying on the suture and almost on the lateral margins; lastly, at apical fourth, there

is on each elytron a transverse bar starting at lateral margin and reaching almost to suture. Underparts finely wrinkled, laterally with white scales. Legs long and slender, pale. Length, 7 millimeters.

Male.—Unknown.

Female.—All ventral abdominal segments apparently simple.

Mount Maquiling, Laguna Province, Luzon (*Baker 1152*).

I have seen but the one specimen, a female, the abdomen of which is distorted so that a complete examination of the segments is impossible.

Callimerus trifoliatus sp. nov. Plate 4, fig. 37.

A small delicate species. Head, thorax, and underparts brown; elytra piceous; antennæ, mouth parts, and legs pale. Head almost impunctate, with very fine wrinkles; scales moderately densely placed near eyes, on clypeus and on vertex; otherwise rather sparse. Thorax almost cylindrical, lateral dilations feeble, anterior transverse impression very shallow, nearly obsolete, basal deep and distinct, basal marginal bead broad and well elevated; disk with a smooth median longitudinal line, otherwise moderately densely punctured, the punctures large and small mixed; except for median line, moderately densely clothed with white scales. Elytra long and slender, suture closed almost to tips which are internally obliquely rounded, neither angle mucronate; surface alutaceous with deep and sparse punctures placed somewhat in rows, especially on basal half, most of surface set with white scales, these absent on the following spots: The humeral callus and a subscutellar spot; two spots, the sutural twice the size of the marginal, at basal fourth, the marginal connected with the humeral by a narrow line; a large spot postmedian which is deeply indented before and behind and connected with the sutural spot of the preceding; an irregular spot at apical fourth; and a subapical spot, the last small. The suture and margins are also nude. Underparts alutaceous, laterally clothed with white scales. Legs long and thin, tarsal claws almost simple. Length, 6 millimeters.

Male.—Unknown.

Female.—All ventral segments apparently unmodified.

Type, a female from Sibuyan (*Baker*).

CLERINÆ

Subfamily characters.—Cleridæ; eyes emarginate anteriorly, the emargination variable in size, antennæ eleven-segmented, filiform or with the segments beyond the fourth wide, subtriangular, usually with a more or less well defined club; thorax variable in form, usually without cariniform lateral margins, anterior coxal cavities open more or less widely behind; elytra occasionally abbreviated; abdomen with the sixth sternite small; legs moderate to long, the femora often clavate, tarsi five-segmented, the first (in the Philippine genera) small and covered by the second, second usually the longest, claws simple or with a basal tooth, never tripartite.

The largest of all the subfamilies of the family and the most difficult in which to define generic limits. This is especially true of the *Stigmatium-Thalerocnemis* complex. In his original paper, Kuwert apparently accepts the following genera: *Pseudoclerops* duVal, *Stigmatium* Gray, *Operculiphorus* Kuw., *Dasyceroclerus* Kuw., and *Placocerus* Klug. The first stands alone; the second includes the subgenus *Astigmus* Kuw.; the third stands alone and is based on a single species with exaggerated male sexual characters; the fourth includes, besides the typical subgenus, five subgenera as follows: *Chlorocnemis* Kuw. (renamed *Thalerocnemis* by Lohde), *Rhytidoclerus* Kuw., *Xestonotus* Kuw. (for which *Xestoclerus* nov. nom. is here proposed since Kuwert's name is antedated by *Xestonotus* Leconte 1853), *Phaeocyclotomus* Kuw., and *Cyclotomocerus* Kuw. The last, with its subgenus *Cardiostichus* Quedf., does not concern us here, all the species being African.

Schenkling[2] places *Pseudoclerops* as a subgenus of *Stigmatium*, retaining *Astigmus* as originally assigned. All of the subgenera of *Dasyceroclerus* are raised to generic rank. In his later work[3] *Pseudoclerops* is restored to generic rank, *Stigmatium* is left in other respects as in 1903, *Thalerocnemis* is made a subgenus of *Dasyceroclerus*, while the others are continued as valid genera. In the present paper, *Operculiphorus* is recharacterized in order that undue weight may not be placed on a secondary sex character; *Pseudoclerops*, *Cyclotomocerus*, and

[2] Gen. Ins. (Wytsman) (1903). [3] Col. Cat. (Junk) (1910).

Astigmus are extralimital but may be discovered in the Philippines at a later date. *Rhytidoclerus, Dasyceroclerus, Thalerocnemis,* and *Phaeocyclotomus* are maintained as distinct and all are represented in the Philippine fauna.

Neoclerus Lewis and *Thaneroclerus* Lef. are removed from the Clerinæ to form, together with certain extralimital genera, the new subfamily Thaneroclerinæ. Gahan 1910 is followed in assigning *Tarsostenus* Spin. to the Korynetinæ. Two new genera have been proposed for certain new species.

The genera that are known to occur in the Philippines are separated in the following manner:

Key to known Philippine genera of Clerinæ.

1. Eyes coarsely granulate .... 2.
   Eyes finely granulate .... 4.
2. All palpi with triangular apical segments .... **Notoxus** Fabricius.
   Labial palpi only with triangular apical segments .... 3.
3. Thorax and elytra with numerous spinelike bristles in addition to the usual vestiture; size small .... **Anthicoclerus** Schenkling.
   Thorax and elytra without spinelike bristles, vestiture fine and rather sparse; size large .... **Orthrius** Gorham.
4. Base of thorax not strongly constricted, basal transverse impression remote from basal margin and rather feeble, sides of thorax not strongly dilated .... 5.
   Base of thorax strongly constricted, basal transverse impression close to basal margin and rather deep, sides of thorax dilated and rounded .... 6.
5. Form cylindrical, elytra with rows of punctures .... **Omadius** Castelnau.
   Form strongly depressed, elytra irregularly punctate.
   Pseudomadius g. nov.
6. Antennæ with all segments beyond the second thin, equal in width and subequal in length .... 7.
   Antennæ with the segments toward the end becoming triangular and wider, forming a more or less distinct club .... 11.
7. Form cylindrical, not depressed .... 8.
   Form broad and depressed .... 9.
8. Form slender, elytra slightly wider just behind the middle than at base, thorax transverse .... **Operculiphorus** Kuwert.
   Form robust, elytra parallel to about apical third from which point they narrow to apex; thorax longer than broad.
   Dasyceroclerus Kuwert.
9. Elytra with rasplike punctures on basal half ..... **Rhytidoclerus** Kuwert.
   Elytral punctures simple, not rasplike .... 10.
10. The stout spinelike bristles on the apical half of the elytra arise from tubercles .... **Phaeocyclotomus** Kuwert.
    The stout spinelike bristles on the apical half of the elytra do not arise from tubercles .... **Thalerocnemis** Lohde.

11. Large; elytra with rows of coarse, rasplike punctures on basal half. **Stigmatium** Gray.
    Small; elytra without rasplike punctures on basal half. **Coptoclerus** g. nov.

Genus **NOTOXUS** Fabricius

Notoxus FABRICIUS, Syst. Ent. (1775) 158; GAHAN, Ann. & Mag. Nat. Hist. VIII 5 (1910) 66.

Opilo LATREILLE, Hist. Nat. Crust. Ins. 3 (1802) 111; LACORDAIRE, Gen. Col. 4 (1857) 438; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 33; Col. Cat. (Junk) Cleridae (1910) 32.

Opilus AUCTT.

Eupocus ILLIGER, Mag. Insektenk. 6 (1807) 341.

As has been shown by Gahan (1910), Fabricius himself has, by elimination, fixed the type of *Notoxus* as *N. mollis* Linn. For a discussion of the technical aspects of the case, see his paper.

Generic characters.—Clerinæ; eyes large, prominent, coarsely granulate, semicircularly emarginate; antennæ eleven-segmented, first segment stout, bent, second cylindrical, shorter than third, third to eighth cylindrical, each shorter than its predecessor, ninth and tenth subtriangular, as broad as or broader than long, eleventh oval, subtruncate; labrum bilobed; terminal segments of both maxillary and labial palpi triangular. Thorax longer than broad, hardly constricted at base, sides feebly dilated, anterior coxal cavities open. Elytra covering the abdomen, sides parallel, tips together rounded, coarsely serially punctate. Abdomen with six visible ventral segments, legs moderately long, femora not swollen, tarsi with first segment concealed beneath the second, claws simple.

Genotype, *Notoxus mollis* (Linn.).

Geographic range, Palæarctic, Ethiopian, and Australian Regions. The type species has been reported from the United States. As yet the genus is not known from South America.

Schultze has listed *Opilo mollis*, a European species, as Philippine, probably on the statement by Gorham, 1878. If there is a species of this genus in the Islands, and doubtless there is, it will more likely prove to be *niponicus* Lewis or a related species.

Genus **ANTHICOCLERUS** Schenkling

Anthicoclerus SCHKLG., Deutsche Ent. Zeit. (1906) 264.

Generic characters.—Clerinæ; head short, front broad, eyes prominent, rather coarsely granulate, feebly and shallowly emar-

ginate; antennæ eleven-segmented, first segment short and thick, second almost as long as first but only half as thick, third half again as long as second, fourth to seventh each shorter than the preceding but of equal thickness, eighth to tenth wider than the preceding and each about as wide as long, eleventh twice as long as wide, acuminate, labrum emarginate; terminal segment of maxillary palp subulate, that of labial palp elongate-triangular, the apex very obliquely truncate. Thorax transverse, widely dilated at sides, anterior transverse impression distinct, strongly constricted at base, anterior coxal cavities open behind. Elytra covering abdomen, with rows of more or less well defined punctures. Abdomen with six visible ventral segments. Legs moderate, tarsi with second and third segments very thick, without conspicuous lobes, fourth segment short, lobed beneath, claws thin and long, simple.

Genotype, *Thanasimus anthicoides* Westw.

Geographic range, the Indo-Malayan Region.

The genus contains but one species with one variety.

Anthicoclerus anthicoides (Westwood). Plate 2, fig. 10.

Thanasimus anthicoides WESTWOOD, in White, Cat. Col. Brit. Mus., Cler. (1849) 59, Proc. Zool. Soc. London (1852) 43, pl. 27, fig. 8.
Thanasimus pallipes GORHAM, Trans. Ent. Soc. London (1878) 162; SCHENKLING, Ent. Mitteil. 5 (1916) 221.

Form short and broad, depressed. Color piceous, each elytron with two large pale spots. Head sparsely and finely punctured, antennæ with the first two or three segments castaneous, the rest almost black; maxillary palp dark, the apex of the terminal segment slightly paler, labial palp pale. Thorax black, shining, with a few scattered punctures over the surface, the bristles on the flanks quite conspicuous. Elytra with rows of fine punctures, these rows very indistinct on the outer half of each elytron, in some specimens surface between the punctures shining, hairs and bristles moderately dense; color piceous black, each elytron with a large irregular pale spot just behind the base and another near the apex. Underparts castaneous to piceous, the first abdominal sternite paler, the surface finely and sparsely punctured, moderately clothed with brown hair. Legs moderate, black, the second tarsal segment very thick and heavy. Length, 2.5 to 3 millimeters.

Male.—Sixth abdominal sternite with very shallow emargination across the middle of the posterior margin. Terminal tergite broadly rounded.

Female, not seen.

Ceylon (type). Sumatra. New Guinea. Borneo. Philippine Islands, Mindanao, Davao Province, Davao (*Baker 6700, 6697*); Lanao Province, Iligan (*Baker 13515*).

The species appears to be rather variable. In a fairly long series of specimens from each of several localities there is great variation in the degree of coarseness of the elytral punctuation as well as in the amount of pubescence on the upper surface. It appears impossible to make any satisfactory split in the material.

Genus ORTHRIUS Gorham

Orthrius GORHAM, Cist. Ent. 2 (1876) (1875–1882) 74; Ann. Mus. Stor. Nat. Genova II 12 (1892) 737; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 45.

Generic characters.—Clerinæ; form elongate, parallel, subdepressed. Head wide in front, eyes coarsely granulated and almost entire; labrum emarginate; antennæ eleven-segmented, first segment stout and bent, second subglobose, about as long as thick, third to eighth moniliform, subequal, ninth and tenth transverse, each about as long as the eighth, eleventh longer than tenth, somewhat acuminate, excavate on the internal margin, terminal segment of maxillary palp cylindrical, about three times as long as wide, that of labial palp angular, broadly dilated and very obliquely truncate at tip. Thorax with length and breadth subequal, constricted at base, anterior transverse impression feeble, anterior coxal cavities broadly open behind. Elytra covering the abdomen, punctate-striate throughout their length. Abdomen with six visible sternites, in the male sex occasionally (or always ?) with profound secondary modifications. Legs moderate in length, tarsi with the first segment short, the second shorter than third and fourth together, claws slender, simple.

Genotype, *Orthrius cylindricus* Gorham.

Geographic range, Indo-Malayan and Australian Regions.

A moderately large genus of medium-sized, mostly brownish species. Of the three species before me, one appears to have

been described previously under three different names and is widely distributed. The remaining two are, to the best of my knowledge, undescribed.

Key to species of Orthrius Gorham.

1. Head and thorax black; each elytron with two irregular pale brown spots. **O. binotatus** Fischer.
   Head and thorax castaneous; elytra not as above .... 2.
2. Entire insect, with the exception of the eyes and hind femora, pale; elytra without markings .... **O. pallidus** sp. nov.
   Each elytron with base narrowly, sutural margin, and two transverse bars of dark castaneous on pale brown .... **O. bicrucis** sp. nov.

Orthrius binotatus Fischer. Plate 2, fig. 11.

Orthrius binotatus FISCHER, Bull. Mus. Hist. Nat. Mosc. 2 (1829) Ins. 44; SCHENKLING, Ent. Mitteil. 4 (1915) 248.

? *Orthrius andamanensis* SCHENKLING, Deutsche Ent. Zeit. (1906) 268, (1910) 103.

Orthrius sellatus WESTWOOD, Proc. Zool. Soc. London (1852) 42, pl. 25, fig. 8.

Form rather broad and depressed. Color black, elytra maculate, underparts and most of legs castaneous. Head finely and rather sparsely punctured, sparsely pubescent; labrum, mouth parts, and antennæ castaneous. Thorax slightly wider than long, finely and sparsely punctured, punctures denser on flanks, pubescence sparse. Elytra with ten rows of rather fine punctures, the last row just beneath the marginal bead. Between each two rows there is an irregular row of very minute punctures, hardly visible with a (55 mm. 6 x) binocular; color black or very dark piceous, each with a large irregular spot of pale brown reaching from margin to suture and thus forming, with the corresponding spot on the other elytron, a median band; also just before the apex there is a semicircular sutural spot of the same color. Underparts very finely and rather densely punctured, sparsely pubescent. Legs castaneous, the knees and tarsi of the anterior and middle, the apical third of the femur, and the tibia and tarsus of the posterior piceous; tibiæ with but one short apical spine. Length, 11 millimeters.

Male.—Unknown.

Female.—Abdominal sternites simple, unmodified.

If the above-quoted synonymy is correct, this species has a wide range. Fischer's type was from Bengal, Schenkling's from the Andaman Islands, while Westwood's material was described as from "India orientali." I have seen one Philippine specimen, from Davao, Mindanao (*Baker 7284*). The specimen

appears to fit the description of *sellatus* Westw. in all points noted more nearly than it does that of *andamanensis* Schklg.

Orthrius bicrucis sp. nov.

Form slenderer than in *O. binotatus* Fischer. Head castaneous, front shining, very sparsely and finely punctured, vertex and occiput slightly more densely punctured, epistoma with a few coarse punctures which appear to be symmetrically placed; there are nine along the frontal suture, a median transverse row of four, and six along the clypeal suture; pubescence sparse, erect, and brown. Thorax castaneous, subcampanulate, very smooth and shining, almost impunctate, there being a few punctures along each side of the disk; anterior transverse impression distinct, subangulate at middle, posterior impression deep, posterior margin beaded. Elytra with ten rows of punctures, rows 6 to 9 not crossing the humeral callus, the individual punctures distinct to extreme apex, as well as toward the suture, surface between the punctures shining; color pale brown with the following castaneous markings: The suture, the extreme base of each elytron, a transverse bar at basal third, a second transverse bar at apical third which is distinctly wider where it crosses the suture, and the apices narrowly. Underparts very densely and moderately finely punctured, pale castaneous, legs unicolorous, darker. Length, 6.5 millimeters.

Male.—Fifth abdominal sternite with a broad arcuate emargination, sixth sternite with a smaller but proportionally deeper emargination, the entire surface of the sixth densely covered with short spines, terminal tergite truncate with the lateral angles rounded.

Female.—Unknown.

Type, a male specimen from Luzon, Nueva Vizcaya Province, Imugan (*Baker*).

I have seen but the one specimen of this very interesting species. In appearance it approaches *O. sexplagiatus* Schklg. from the Nilgiri Hills, but may be distinguished by the punctuation of the elytra as well as by the color of the elytral markings. The short spines on the sixth sternite in this and the next species are entirely different from anything I have examined before.

Orthrius pallidus sp. nov.

More robust than the preceding; entirely pale brown, pubescence sparse and erect. Head finely and not sparsely punctured, on each side of the front just above the insertion of the antennæ

is a group of seven large punctures; epistoma with one large puncture at either side and a few smaller ones toward the center. Thorax finely and moderately densely punctured, the region in front of the anterior transverse impression more coarsely so. Elytra with ten rows of punctures, the sixth to the ninth failing at the humeral callosity, punctures reaching the extreme apex, surface between the punctures alutaceous, dull. Underparts alutaceous, finely punctured, and sparsely pubescent. Legs moderate, femora slightly swollen, tibiæ straight and slender, tarsi rather thick. Length, 7 millimeters.

Male.—Almost the same as in *O. bicrucis;* differs in that the emargination of the sixth sternite is straight across the bottom instead of being V-shaped.

Female.—Unknown.

Type, a male specimen from Luzon, Laguna Province, Mount Maquiling (*Baker*).

Genus **PSEUDOMADIUS** novum

Generic characters.—Clerinæ; form elongate, parallel, depressed. Head with eyes about as wide as thorax, vertex narrow, front triangular, eyes large but not prominent, finely granulated, acutely emarginate near base of antennæ, labrum so deeply emarginate as to be apparently bilobed; mandibles stout, curved, with internal tooth near apex, terminal segment of maxillary palp cylindrical, about half again as long as thick, that of labial palp very long and slender, broader toward apex and obliquely truncate; antennæ eleven-segmented, first stout, slightly curved, second globular, third to seventh elongate, equal in size and shape, eighth slightly wider and shorter than seventh, ninth to eleventh forming a compact club, ninth and tenth subequal in length and twice as wide as eighth, eleventh cultriform, its length equal to that of ninth and tenth together. Thorax quadrate, anterior coxal cavities open behind, anterior and basal transverse impression distinct. Elytra covering the abdomen, sides sinuate, apices rounded, thickly and irregularly punctured. Abdomen with six visible sternites, fifth and sixth modified in the male. Legs long, hind femora reaching well beyond apex of abdomen, femora clavate; tibiæ long and slender, first tarsal segment concealed beneath second, second long; claws with slight basal toothlike thickening.

Genotype, *Pseudomadius viridiventris* sp. nov.

Pseudomadius viridiventris sp. nov.

Form elongate, parallel, depressed. Front of head and underparts bright metallic green, thorax and elytra purplish black with golden pubescence, legs pale with dark markings. Head in front of the eyes rather coarsely and densely punctured, between and behind the eyes more finely and sparsely punctured; occipital region transversely rugulose, surface rather thickly set with stiff, suberect golden hairs; labrum testaceous, mandibles black, antennæ piceous, the first segment paler, palpi pale. Thorax slightly wider than long, sides parallel, disk very finely and rather sparsely, sides more densely and coarsely punctured, anterior and basal margins transversely rugulose; on either side of the median line at about basal third is a deep pit, entire surface rather sparsely set with golden pubescence. Elytra flat, covering the abdomen, lateral margins sinuate, each with distinct patches of golden hairs as follows: At the base there are three stripes extending toward the apex for a short distance, one sutural and one on either side of the humeral callosity. The median of these three stripes is continued as an irregularly triangular spot which is joined to its mate on the other elytron across the suture. These markings occupy the basal half of the length. At about apical third there is a short transverse bar across the suture, which becomes obsolete toward the lateral margins. At the apex there is an oval spot common to the two elytra but hardly reaching the lateral margins. This spot is very narrowly connected with the transverse bar along the suture. Underparts finely and rather sparsely punctured, surface between punctures alutaceous. Legs very coarsely wrinkled, femora clavate, the thickest portion toward the base, the vestiture so coarse as to be almost spinous. Length, 8 millimeters.

Male.—Fifth sternite broadly and deeply emarginate. Sixth sternite rather shallowly and less broadly emarginate, last tergite rounded, its margin greatly thickened.

Female.—Terminal tergite and all sternites simple.

Type, a male from Mindanao, Zamboanga Province, Dapitan (*Baker*); paratypes from Surigao (2), Port Banga (1), and Kolambugan (1), Mindanao, received from Staudinger and Bang-Haas.

Owing to the structure of the antennæ and the punctuation of the elytra this very beautiful species cannot be associated with *Omadius*. Its affinities, however, are with that genus. The

clavate femora suggest certain species of *Thalerocnemis*, but there again the antennal differences are of generic rank.

Genus OMADIUS Castelnau

Omadius CASTELNAU, Silberm. Rev. Ent. 4 (1836) 48; SPINOLA, Monog. Clérites 1 (1844) 172; LACORDAIRE, Gen. Col. 4 (1857) 465; KUWERT, Ann. Soc. Ent. Belg. 38 (1894) 62; GORHAM, Proc. Ent. Soc. London (1894) xlii.

Ommadius GORHAM, Ann. Soc. Ent. Belg. 39 (1895) 296, footnote; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 82; Col. Cat. (Junk) Cleridæ (1910) 69.

Generic characters.—Clerinæ; head moderate to large, eyes (in Philippine species) prominent, finely granulated, deeply emarginate, labrum bilobed, terminal segment of maxillary palp cylindro-acuminate, that of labial palp very long, slender, broadened toward apex and obliquely truncate; antennæ eleven-segmented, first segment stout, obconical, second globose, nearly spherical, third to fifth cylindrical, smooth and shining, of equal width but each shorter than the preceding, sixth to tenth triangular, each broader than the preceding but of subequal length, eleventh cultriform or oval, longer than the tenth. Prothorax longer than broad, basal and anterior transverse impressions clearly defined, anterior coxal cavities open behind. Elytra with ten rows of punctures, those near the base sometimes rasplike. Abdomen with six visible sternites, fifth and sixth sternites usually showing some sexual modification in the male. Legs long, femora not clavate; tarsi of five segments, the first lying beneath the second, second longest, third and fourth shorter, fifth as long as third and fourth together; claws with narrow triangular platelike tooth at base.

Genotype, *Omadius indicus* Castelnau, Plate 2, fig. 9.

Geographic distribution, Indo-Malayan and Australian Regions.

The above characterization of the genus is made from *O. indicus* Cast. and *O. nimbifer* Gorh., a closely related species. A study of some thirty species belonging to the genus indicates that it is impossible to give as broad a definition of the antennal form as is necessary to include all types without making the definition too broad to have meaning. The typical species fit the above diagnosis; in the case of aberrant species such as

centralis or *brunneus*, attention is called to those that are at variance with the above statement.

There are at present about one hundred twenty described species assigned to *Omadius;* there is no doubt that many of these so-called species will prove to be worthless. Ten of these have been reported from the region under discussion. One of these, *O. indicus,* probably does not occur here, though there is some possibility that it may be collected on Palawan or Balabac, the species being common on Borneo. It is distinguished from *O. nimbifer* (probably the Philippine species that has been reported as *indicus*) by the extremely rough disk of the pronotum. A second species, *O. posticalis* Gorh., is not known to me in nature; I have placed it in the key as best I can from the meager description available. The remaining eight, together with three which appear to be new, are before me.

Key to Philippine species of Omadius Castelnau.

1\. Elytra reddish yellow, each with three transverse bars of purplish black; legs entirely pale .... 2.
Elytra not as above; legs usually annulate .... 4.

2\. Black bars on elytra narrow, each strongly angulate on disk, bars on the elytra connected across suture; pronotum entirely dark piceous, covered with a dense, depressed golden pubescence.
O. aurulentus Heller.
Black bars on elytra not strongly angulate on disk, each bar rounded at sutural end; suture pale its entire length .... 3.

3\. Pronotum shining black, with but a very few scattered punctures and with no depressed pubescence .... **O. vespiformis** Gorham.
Pronotum bicolored, the posterior third and a large semicircular spot on the anterior margin black, the rest reddish yellow, surface covered with pubescence as in *aurulentus* .... **O. bakeri** Heller.

4\. Elytra piceous, at base castaneous, each with a transverse bar just before the middle, which is widest near the suture and tapers almost to a point on the lateral margin; also with an oblique bipolar spot at apical fourth, reaching from the lateral margin halfway to suture, and with the extreme apices densely covered with depressed golden pubescence; legs pale .... **O. aurifasciatus** Gorham.
Elytra not as above; legs annulate or striped with dark .... 5.

5\. Anterior portion of pronotum smooth, finely punctured; pronotum with a deep transverse depression across disk, elytra pale brown on disk, flanks darker, and with a continuation of the dark onto the discal surface at apical third and with a subapical lunate dark spot. The pale brown portion is covered with dense, depressed silvery pubescence; tibiæ sharply annulate .... **O. brunneus** sp. nov.
Anterior portion of pronotum transversely wrinkled or reticulate .... 6.

6. Anterior portion of pronotum transversely wrinkled; femora with apical half dark, tibiæ largely dark ... 7.
   Anterior portion of pronotum reticulate, tibiæ narrowly annulate.... 8.
7. Elytra each with three irregular bars, the first of two spots nearly connected, the second of one large transverse spot deeply indented behind, the third oval, subapical ... **O. notatus** Gorham.
   Elytra with a single broad fascia behind the middle.
   O. posticalis Gorham.
8. Elytra dark brown, with a broad transverse bar of silvery pubescence; the apical fourth of the elytra is also decorated with similar pubescence ... **O. centralis** (Gorham).
   Elytra not with only a single conspicuous pale transverse bar ... 9.
9. Elytra, with the exception of the flanks, uniform castaneous, decorated with a complicated network of silvery pubescence.
   O. pruinosus sp. nov.
   Elytra dark piceous or black with basal and median transverse bars and apices broadly covered with olive-green pubescence, the apical pubescence inclosing a dark spot ... 10.
10. Subbasal transverse black spot single, not divided by longitudinal band of pale pubescence, subapical dark spot entire, oval; antennæ with segments 3 to 5 dark ... **O. nimbifer** Gorham.
   Subbasal transverse spot double, the fifth interspace being clothed with pale pubescence, subapical spot notched behind; antennæ entirely pale ... **O. kamelianus** White.
   Subbasal transverse spot but half the width of the elytron, the pale pubescence covering most of the surface from the fourth interspace outward (a trace of the original spot occurs in the seventh and eighth interspaces); subapical spot reduced to two minute points; antennæ dark except for basal and apical pale segments.
   O. sibuyanus sp. nov.

Omadius vespiformis Gorham.

Omadius vespiformis GORHAM, Cist. Ent. 2 (1876) (1875–1882) 103.

Head finely punctured, very sparsely so on front between the eyes, rather densely on occiput and very densely just above the epistoma; entirely pale; with a few scattered erect hairs; antennæ rather short, pale with the intermediate segments slightly darker. Pronotum as wide as long, black, highly polished, with only a few dozen setigerous punctures on either side of the median line, anterior transverse impression broad and shallow, basal impression a clean-cut groove, sides rounded between impressions. Elytra with traces of ten rows of punctures, second interspace twice as wide as sutural, individual punctures of the first, second, seventh, eighth, and ninth distinctly smaller than those of the other rows, all punctures obsolete beyond the middle, surface between punctures of rows very finely and densely punctulate; color reddish yellow, each elytron with three transverse purplish black spots. The first in basal fourth, its basal margin

nearly straight, the posterior margin irregular so that the spot is narrowest at the suture, widening rapidly until it reaches its maximum width in the fourth interspace, from whence it extends to the lateral margin with width nearly uniform; the second postmedian, narrower than the first, anterior margin angulate, similar to the posterior margin of the first, posterior margin of second slightly arcuate; the third subapical, suboval and oblique. Pubescence dense and depressed, golden on the reddish yellow portions, black on the spots. Underparts pale except for the side pieces of the mesothorax and the posterior coxæ which are piceous. Punctuation rather coarse on the abdomen, finer on the thorax. Legs reddish yellow, immaculate. Length, 12 millimeters.

Sex uncertain in the specimens before me. All abdominal sternites and the terminal tergite simple.

"East Mindanao, Philippines." Two specimens from Surigao, Surigao Province, Mindanao (*Baker 16172*).

The only Philippine species known to me in which the usual dense, depressed pubescence on the pronotum is absent. In this character, the insect resembles *O. fasciatus* Kuw. from Celebes.

In his original description of *O. bakeri*, Heller refers to *O. vespiformis* as having "granules" on the disk of the pronotum. There is no mention of this in Gorham's original characterization of the species, nor am I able to detect any on the specimens before me.

Omadius bakeri Heller.

Ommadius bakeri HELLER, Philip. Journ. Sci. 19 (1921) 533.

Form parallel, depressed. Head entirely pale, finely and densely punctured, pubescence mostly erect and pale; antennæ of usual form, entirely pale. Pronotum equilateral, sides rounded between the anterior and basal transverse impressions, anterior impression obsolete across disk, basal complete, clearly defined; surface densely and finely punctured on disk, more sparsely on flanks, pubescence moderately dense and depressed; color reddish yellow, the basal third and a transverse interocular spot on the anterior third black. Elytra almost the same as in *O. vespiformis* Gorh. but with the fine punctures slightly more densely placed and with slightly different markings; the first spot does not extend across the suture, but ends in the second interspace; the second spot also fails the suture and is more excavate on its posterior margin; the subapical spot is similar in shape to that of *vespiformis* but is smaller and more clearly

defined. Lateral portions of the mesosternum and the posterior coxæ are black, otherwise the underparts are reddish yellow. The metathorax is finely and densely punctured, the abdomen very sparsely so; the femora are finely rugose. Length, 12 millimeters.

Specimens of but one sex are before me; the abdominal sternites are simple.

"Luzon, Laguna Province, Mount Maquiling (*1974*)." Two specimens from the same lot received from Professor Baker.

Omadius aurulentus Heller.

Ommadius aurulentus HELLER, Philip. Journ. Sci. 19 (1921) 533, pl. 1, fig. 10.

Form elongate, depressed, slightly attenuate posteriorly. Size large. Head in front finely and densely punctured, occiput irregularly transversely rugulose, front densely clothed with rather long golden pubescence; antennæ of usual form, entirely pale. Pronotum piceous, densely and finely punctured above, flanks almost impunctate, anterior transverse impression broad and deep, basal broad and shallow, polished; disk rather densely clothed with golden pubescence. Elytra with ten rows of punctures which become obsolete at about the middle of the length, pale reddish yellow with three undulating black bars, the first and narrowest before the middle, the second postmedian, the third subapical, the second and third almost equal in width; pubescence fairly equally distributed over the surface, that arising from the black bars black, that from the reddish yellow portions golden. Underparts mostly reddish yellow, the pro- and mesosterna piceous, thoracic sclerites finely and densely punctured, the abdomen sparsely so. Legs reddish yellow, tibiæ slightly darker. Length, 16 to 17 millimeters.

Male.—Fifth and sixth abdominal sternites transverse, feebly emarginate, terminal dorsal broadly and somewhat deeply so.

Female.—Fifth sternite with a small U-shaped emargination. Sixth almost entire, terminal dorsal rounded.

Mount Maquiling, Laguna Province, Luzon. A pair of this fine species sent me by Baker under his No. 11545, five specimens from Mount Banahao, two from Mount Isarog, and one from Imugan received from Staudinger and Bang-Haas.

Omadius aurifasciatus Gorham.

Omadius aurifasciatus GORHAM, Cist. Ent. 2 (1876) (1875–1882) 102.

Form cylindrical, depressed, tapering behind. Head rugose-punctate on front, transversely rugose on occiput, labrum and

clypeus pale, impunctate, epistoma with a few large punctures at sides; antennæ of usual form, entirely dark. Pronotum entirely pitchy, sides nearly straight, wider anteriorly, anterior transverse impression broad and rather deep, basal clean-cut; on the disk is a short median longitudinal groove extending from the anterior impression halfway to basal, anterior portion coarsely and sparsely punctured, disk with two patches of fine, densely placed punctures, otherwise sparsely and somewhat coarsely punctured; pubescence from fine punctures greenish golden, otherwise dark. Elytra with coarse rasplike punctures at base, puncture rows becoming obsolete at median transverse fascia; color piceous, humeri ferrugineous, each elytron with three patches of greenish golden pubescence as follows: The first in the form of a transverse bar, widest at fourth puncture row, posterior margin straight; the second comma-shaped, starting at the middle of the elytron at the apical third and extending outward and apically to the lateral margin; in the third the apices are narrowly covered with the pubescence. Underparts and legs dark ferrugineous, posterior coxæ piceous. Length, 12 to 14 millimeters.

Male.—Terminal abdominal tergite with a broad shallow emargination, sternite simple.

Female.—Fifth abdominal sternite with a small, semicircular emargination; sixth sternite entire; terminal tergite emarginate.

"East Mindanao, Philippines." Two specimens before me from Iligan, Lanao Province (*Baker 12742*), and Butuan, Agusan Province (*Baker 17587*), both localities in Mindanao.

Omadius centralis (Gorham).

Stigmatium centralis GORHAM, Cist. Ent. 2 (1876) (1875–1882) 94.

Form depressed, approaching that of *Stigmatium*. Head between and below the eyes reticulate, on occiput transversely rugulose, sparsely pubescent. Color piceous except for frons which is pale. Epistoma with a few very large punctures. Antennæ with the sixth to eighth segments hardly dilated, ninth distinctly smaller than tenth, tenth and eleventh together forming a short oval club; first segment and apical half of eleventh segment pale. Pronotum longer than broad, wider in front, anterior transverse impression indistinct, basal as usual, anterior portion finely reticulate, disk very finely and densely punctured, median transverse impression very feeble but present, connecting the lateral foveæ, surface densely covered with depressed pale pubescence.

Elytra with ten rows of punctures which extend to apical fourth, the second and fourth interspaces each wider than either the sutural, third, or fifth; color piceous; on the second fourth of the length is a broad transverse fascia of pale depressed pubescence, complete across suture, very narrow at lateral margins, with anterior and posterior margins nearly straight; at apical fourth there is a narrow undulating crossbar which is connected with the apical pubescent patch by a narrow sutural line of pubescence. Underparts of thorax piceous, abdomen reddish yellow. Apical third of femora dark with subapical narrow pale annuli; tibiæ annulate at base and at middle with dark; tarsi pale. Length, 7.5 to 8.5 millimeters.

Male.—Sixth abdominal sternite feebly emarginate, the depth of the emargination varying.

Female.—Sternites simple.

"East Mindanao, N. E. Luzon." Material before me as follows: Mount Maquiling, Laguna Province, Luzon (*Baker 582, 1975, 3038*); Malinao, Tayabas Province, Luzon (*Baker 6082*); Negros (collector unknown, specimens received from Dr. K. Jordan); Surigao, Surigao Province, Mindanao (*Baker 16171, 17586*).

There is some slight variation among the specimens, but it does not appear to be correlated with distribution. The above diagnosis is taken from a Surigao specimen which fits the original description in all particulars.

Omadius brunneus sp. nov.

Form cylindrical, depressed; size rather small for the genus. Head very finely punctured, below the eyes very densely, between and above them very sparsely; interocular carina very sharply defined, pubescence sparse, depressed, pale; color castaneous, labrum and epistoma testaceous; antennæ castaneous, the first two segments pale, seventh to tenth segments very feebly triangular, nearly circular in cross section, eleventh as long as three preceding, flattened. Pronotum somewhat more constricted at base than is usual in the genus, anterior and basal transverse impressions narrow and distinct, a deep and broad transverse groove across the middle which ends at either side near two conspicuous pits, surface very finely and sparsely punctured, pubescence moderately dense, depressed, pale yellow; color castaneous, flanks slightly darker. Elytra with ten rows of punctures on each, the punctures of the first and second rows

smaller than those of the succeeding rows, sixth and seventh rows the longest, reaching to about apical fifth, tenth row short, hardly exceeding the middle of the length. The space inside the sixth row on the basal half is pale yellow-brown, as is also most of the apical fourth. Outside the sixth row the color is dark castaneous with one or two small spots of paler brown; just beyond the middle the dark color is extended toward the suture as a narrow bar which reaches the second row of punctures and then runs apically a short distance between the second and fourth rows. This transverse bar is also extended apically for a short distance along the sixth and seventh rows. There is a small transverse dark spot on the apical pale portion. Pubescence fine and depressed, colored as the surface from whence it arises. Underparts finely and densely punctured, pale yellowish. Legs pale, the apices of the femora and an annulus on each tibia dark, tarsi slightly darker than rest of legs. Length, 6 millimeters.

Type, a specimen (sex undetermined) from Mount Banahao, Luzon (*Baker*).

This species, while quite atypical of the genus, does not present characters of sufficient importance to warrant the erection at this time of a new genus to contain it.

Omadius pruinosus sp. nov.

Form of *O. notatus* Gorh. Size rather small for genus. Head moderate, finely and densely punctured, sparsely pubescent except around eyes; antennæ normal for the genus, terminal segment as long as four segments preceding, apical half pale; interocular carina entirely absent. Pronotum slightly longer than broad, widest just before the middle, anterior and basal transverse impressions distinct, median transverse impression very feeble and indistinct, surface finely and densely punctured, finely reticulate anteriorly, rather densely pubescent, the pubescence strongly depressed. Elytra with rows of rather small punctures, surface very densely clothed with short, depressed pubescence of two colors. The greater part of the surface is covered with dark brown hairs which show a slight iridescence. On the basal half and toward the apices there are a few irregular lines of silvery pubescence forming a very intricate but quite indefinite design. The entire upper surface of the insect is dark castaneous, the flanks of the thorax and elytra piceous. Underside of thorax castaneous, finely alutaceous, and sparsely pubescent. Abdomen pale yellow-brown, finely and sparsely punc-

tured, the surface between the punctures alutaceous. Legs pale, the femora annulate just before the apices, the tibiæ annulate both at the base and at the middle; tarsi rather dark. Length, 7 millimeters.

Type, a specimen (sex undetermined) from Mount Banahao, Luzon (*Baker 3037*).

The sculpture of the pronotum is by far the least pronounced of any species with the reticulate anterior margin. The insect, in fact, is the most delicately formed and graceful of the species known to me. It appears to have no near relatives in the Philippines.

Omadius notatus Gorham.

Omadius notatus GORHAM, Cist. Ent. 2 (1876) (1875–1882) 103.

Form cylindrical, depressed, slightly tapering posteriorly. Head very densely and finely punctured, front thickly clothed with long pale hairs, eyes very prominent, interocular carina short, blunt, rather low down on front, epistoma with a few very large, more or less lozenge-shaped punctures, labrum and first antennal segment pale, rest of antenna piceous. Pronotum densely and evenly clothed with fine depressed pale pubescence, anterior and basal transverse impression distinct, median transverse impression obsolete, anterior portion with coarse transverse ridges, color piceous. Elytra with ten rows of punctures, the punctures themselves becoming indistinct just beyond the middle of the length, tenth row as long as ninth, all rows continued as grooves nearly to apex; surface very minutely punctate, pubescence moderately dense and depressed; each elytron with three dark spots, on which the pubescence is black, as follows: One just before basal third, transversely oval, reaching from the first to the tenth puncture rows and crossed by a very narrow bar of pale pubescence in the sixth interspace; a second, post-median, larger than the first, attaining the suture but narrowly separated from the lateral margins, deeply and broadly indented anteriorly at the seventh interspace and posteriorly at the fifth and sixth interspaces; the third subapical, small, oval, separated from the lateral margin and suture as the first; remaining surface of elytra with pale pubescence. Underparts of thorax and hind coxæ dark. Abdomen pale, all finely and densely punctured, sparsely pubescent. Legs long, femora with apices and an internal marking dark; tibiæ with more than the middle third dark, tarsi pale. Length, 7.5 to 11 millimeters.

Male.—Fifth abdominal sternite emarginate to a greater or lesser degree, sixth sternite and terminal dorsal rounded.

Female.—Fifth sternite broadly rounded, the rounded portion slightly in advance of the rest of the posterior margin; sixth sternite rounded, terminal dorsal subtruncate.

"East Mindanao, Philippines." Specimens before me are from the following localities in Mindanao: Zamboanga (*Baker 4275*), Davao (*Baker 4276, 11905*), Butuan (*Baker 17585*), and Surigao. There are also two specimens from Luzon, Laguna Province, Los Baños (*Baker 574*) and Mount Maquiling (*Baker 4277*).

Attention is here called to the variability of the secondary sexual modification of the male abdomen in species of *Omadius*. In certain genera, as for instance *Callimerus*, the specimens from a given locality do not vary perceptibly. In *Omadius*, on the other hand, hardly two males from the same identical locality will be alike so far as the depth and breadth of the emargination of the fifth abdominal sternite are concerned. In other respects the specimens do not apparently differ. It was my good fortune recently to examine a series of *Omadius indicus* Cast., of which eleven specimens were males, all collected at the same place. It was possible to select five specimens from the lot that differed sufficiently in the conformation of the abdomen to allow of differentiation by word description. This variability applies equally to the fourth sternite. There is no doubt in my mind that *Omadius fallax* Kuw. and *O. similis* Kuw. are both synonyms of *O. fasciipes* Westw. as I have been able to separate the three "species" out of a series of individuals from Borneo. Kuwert's species are both based on variations in the abdominal sternites. It may also be that *O. notatus* Gorh., described above, will fall as a synonym of Westwood's species. For the present they are considered distinct, though very closely allied.

Omadius nimbifer Gorham.

Omadius nimbifer GORHAM, Cist. Ent. 2 (1876) (1875–1882) 102.

Form of *O. notatus* Gorh. but larger in size. Head densely punctured, the punctures between and behind the eyes fine, those low down on the front coarse and somewhat confused; interocular carina low down, broad and short; color pale except for the piceous epistoma; antennæ as in the generic diagnosis, pale, the third to fifth segments darker. Pronotum longer than broad, sides nearly straight, widest toward the front, anterior and basal transverse impressions distinct, portion anterior to the anterior

impression coarsely reticulate, remainder finely and densely punctured, rather densely clothed with pale depressed hairs. Elytra punctured as in *O. notatus*. Maculations much as in that species but differing as follows: The first is not crossed by a line of pubescence in the sixth interspace but is invaded on the posterior margin by a long finger of pubescence in the fifth interspace; the spot also attains both the lateral and the sutural margins. The second attains the lateral margin broadly, is hardly indented anteriorly but is indented posteriorly along the fourth and fifth interspaces. The third spot is similar in the two species. The elytra are pale at the extreme base but otherwise are very dark piceous, relieved by the patches of pale pubescence. Underparts finely and densely punctured, pale reddish yellow except for the lateral portions of the mesothorax and the posterior coxæ. Anterior and middle femora pale with a small external dark spot at apical third; posterior femora and all tibiæ annulate; tarsi pale. Length, 11 to 14 millimeters.

Sexual characters.—The description under *O. notatus* Gorh. will apply to this species equally well, except that the terminal dorsal segment of the male is more truncate than rounded.

"East Mindanao and Luzon." The material before me is all from various localities on Mindanao; Butuan (*Baker 4270, 17588*), Zamboanga (*Baker 7291*), Dapitan (*Baker 11874*), Iligan (*Baker 12740, 12741*), and Kolambugan (*Baker 13520*).

Omadius kamelianus White.

Omadius kamelianus WHITE, Cat. Cler. Brit. Mus. (1849) 53.

Form similar to that of the preceding species but smaller. Head very minutely punctured, occiput finely and indefinitely rugulose, front below eyes more coarsely and distinctly punctured, interocular carina as in *O. nimbifer*. Color pale, front densely clothed with long pale hairs. Pronotum longer than broad; anterior and basal transverse impressions distinct; disk finely and sparsely punctured, portion anterior to anterior impression feebly reticulate; pubescence sparse, depressed, pale; color pale olive green, underparts dark. Elytra with puncture rows extending to beyond postmedian dark spot, surface between punctures finely punctulate. Maculations as described in key; the postmedian is transversely reniform in shape, touching the suture but not crossing the tenth interspace, emargination on posterior border occurring at the fifth interspace and including part of the fourth and sixth. General color paler than in either the preceding or following species. Mesosternum dark, rest of underparts pale. Anterior and middle legs pale except for a very small spot on

the external face of each femur, posterior femora annulate at apical third and at apices, posterior tibiæ with indistinct annuli at middle. Length, 10 millimeters.

Male.—Unknown.

Female.—Characters similar to those of *O. notatus* Gorh.

"Philippine Islands." Material before me from Mount Banahao, Luzon (*Baker 581*).

I should merge *O. kamelianus* White, *O. nimbifer* Gorh., and *O. sibuyanus* sp. nov. into one under the first name were it not for the fact that the material from each of the three islands appears to be constant and different. The differences are unfortunately in the facies rather than in any definite describable character.

Omadius sibuyanus sp. nov.

Length of *O. kamelianus* White but more robust. Head distinctly transversely rugulose on occiput, front finely and densely punctured, interocular carina almost obsolete, situated low down on the front on a small dark spot. Color pale, except for the above-mentioned spot and the epistoma. Pronotum dark olive green, with anterior and basal transverse impressions distinct, anterior portion more coarsely reticulate than in *O. kamelianus*, disk finely, sides more coarsely and densely punctured, pubescence pale and depressed, moderately dense. Elytra dark olive with black spots; postmedian spot on each elytron strongly undulate, reaching suture but very narrowly separated from lateral margin, twice indented on anterior margin (on the second and third, and on the seventh and eighth interspaces), thrice indented on the posterior margin (on the first or sutural, on the fifth and sixth, and on the ninth interspaces). The humeral callus is also dark piceous. Pro- and mesosterna piceous, lateral portions of metasternum dark, rest of underside reddish yellow. Anterior and middle femora annulate with dark just before apices, apices themselves dark, posterior femora dark at bases and apices and with dark annuli; all tibiæ broadly annulate; tarsi pale. Length, 10 millimeters.

Male.—Unknown.

Female.—Characters as in *O. notatus* Gorh.

Type, a female from Sibuyan (*Baker 18585*); paratype, same data (*Baker 18586*).

Closely related to the two preceding species but, I believe, distinct. The two specimens before me are identical and are quite different in appearance from any of the long series of *O. nimbifer* Gorh. that I have studied.

Omadius posticalis Gorham.

Omadius posticalis GORHAM, Cist. Ent. 2 (1876) (1875–1882) 105.

As this species is unknown to me, I quote Gorham's original description in its entirety.

Brevior, niger, prothorace transversim subtiliter rugoso, elytris piceis cinereo pubescentibus, basi seriatim punctatis, striis fere integris, fasciâ latâ pone medium nigrâ, pedibus nigris, tibiarum atque femorum basi, tarsisque testaceis, pectore et abdomine rufis. Long. lin. 4½.

A little like *O. femoralis*, but the fascia is placed further behind, the antennae are much shorter, the two basal joints pale, but the short club entirely black, the thorax transversely wrinkled especially in front, and shorter than in *femoralis*, legs nearly black, only the base of thighs and tibiæ and underside of anterior thighs pale, breast red, etc.

Habitat: Philippines, (Semper).

From the above, it appears that the species is nearest to *O. notatus* Gorham of any of the known Philippine forms. At any rate, it is if the characters selected for the key are of fundamental value, as I believe they are.

Genus **OPERCULIPHORUS** Kuwert

Operculiphorus KUWERT, Ann. Soc. Ent. Belg. 38 (1894) 399 and 410; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 76.

Generic characters.—Clerinæ; form elongate, slightly wider at middle of elytra, *Omadius*-like. Eyes finely granulate, moderately and acutely emarginate, labrum emarginate; antennæ eleven-segmented, first segment stout, slightly bent, second small, globular, third to tenth thin and long, equal in width and subequal in length, each with a few long hairs, eleventh longer than tenth, acuminate; terminal segment of maxillary palp cylindro-acuminate, that of labial palp broadly dilated toward the obliquely truncated apex. Thorax transverse, slightly constricted at base, anterior transverse impression moderate, anterior coxal cavities open behind. Elytra slightly dilated toward the middle of their length, the apices together rather abruptly rounded, punctate-striate, the punctures becoming obsolete just before the apex. Abdomen with six visible sternites, legs rather long, femora swollen, tarsi with the second segment overlying the first, the claws with small basal tooth. Males sometimes with very large terminal abdominal tergite.

Genotype, *Operculiphorus tubifer* Kuwert.

Geographical range, Malayan Region.

This genus was originally erected to care for a species with a very accentuated male secondary sexual character. That char-

acter in itself would hardly be sufficient to sustain the genus; but, if the elongate form and the broadening of the elytra are taken into consideration, the genus may be retained. In a series of several as yet undescribed species from Borneo the males show a regular and gradual reduction in the size of the terminal tergite. For this reason I have assigned the following species to this genus, even though the external male sex characters are but feebly developed:

Operculiphorus philippinus sp. nov.

Form elongate, head and thorax short. Color piceous, the anterior and posterior margins of the thorax, the first and second segments of the antennæ, the palpi, and parts of the legs castaneous. Head sparsely punctured, especially between the eyes, the punctures on the vertex and occiput finer than those on the epistoma; pubescence sparse, pale, suberect. Thorax transverse, almost as wide at base as at apex, anterior transverse impression feeble, disk densely and moderately coarsely punctured; in front of the anterior transverse impression the punctures are replaced by transverse wrinkles, flanks smooth, very sparsely punctured; lateral dilations with circular fovea on each; pubescence denser on disk and on margins. Elytra with ten rows of punctures extending almost to apex, surface shining, clothed with both dark and pale depressed hairs and with a few spinelike bristles arising from intervals 3, 5, and 9; the dark depressed hairs are concentrated in three patches on each elytron, one subcircular at basal third near suture, a second slightly postmedian and directly behind the first, and a third, very irregular in shape, subapical, reaching from margin to suture. Underparts finely and sparsely punctured, surface between the punctures alutaceous. Legs moderately long, the basal half of the femora pale. Length, 3.5 to 5 millimeters.

Male.—Terminal abdominal tergite broadly rounded, slightly larger than the corresponding sternite, which is very feebly emarginate.

Female.—Unknown.

Type, a male from Basilan (*Baker*); paratype, a male from Dapitan, Zamboanga Province, Mindanao (*Baker*).

This species differs from the genotype, *O. tubifer* Kuw., in having the thorax less distinctly constricted at the base and in having the last abdominal tergite hardly larger than the sternite. While the genus is not very distinct from *Thalerocnemis*, there is still a difference in facies which is worthy of recognition.

Genus RHYTIDOCLERUS Kuwert

Rhytidoclerus KUWERT, Ann. Soc. Ent. Belg. 38 (1894) 400 and 419; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 78.

Generic characters.—Clerinæ; form robust, subdepressed. Head vertical, front between the eyes moderately narrow, eyes finely granulated, rather deeply emarginate, labrum bilobed; antennæ eleven-segmented, first segment stout, slightly bent, second short and globular, third slender and longer than any other segment, fourth to tenth thin and narrow, each widest at its middle and each with a few long hairs, eleventh longer than tenth, parallel, acute at apex. Terminal segment of maxillary palp stout, cylindro-acuminate, that of labial palp long, strongly widened toward apex, which is obliquely truncate. Thorax transverse, sides rounded, basal transverse impression deep and distinct, anterior transverse impression feeble, anterior coxal cavities narrowly open. Elytra broadest at base, acute at apex, punctate-striate, the punctures coarse and rasplike on the basal half, becoming obsolete behind the middle; surface with a few coarse spinelike bristles which do not arise from distinct tubercles. Abdomen with six visible ventral segments. Legs moderate, femora not particularly swollen; tarsi of five segments, the second overlying the first and longer than any of the others, claws with a basal tooth. In the male, some of the abdominal sternites may be modified, and the claws of the anterior pair of legs bear a much larger basal tooth than the others.

Genotype, *Stigmatium basipenne* Chevrolat.

Geographical distribution, Malayan and Australian Regions.

Up to this time there have been four species assigned to this genus. A fifth, described by Gorham as *Stigmatum subfuscum*, is now added.

Rhytidoclerus subfuscus (Gorham).

Stigmatium subfuscum GORHAM, Cist. Ent. 2 (1876) (1875–1882) 94.

Color above uniform piceous, abdomen and parts of legs reddish. Head finely punctured, more densely on epistoma and occiput, less densely between the eyes, pubescence sparse and yellowish, a tuft of snow-white hairs in the ocular emargination and antennal groove; antennæ piceous, the first and second segments pale reddish. Thorax finely and not densely punctured, rather thickly clothed with depressed yellowish pubescence. Elytra with rows of coarse punctures on basal half, the first seven rows complete, the eighth represented by a few punctures at the base and a few at about the middle, the ninth represented

by a few punctures at about the basal third, while the tenth is submarginal and is complete or virtually so. Basal half of elytra rather densely clothed with pale depressed pubescence, this becoming still denser at its posterior limit. There is then what appears under low power to be a nude transverse fascia but what is in reality a bar of very fine short black hairs. Beyond this is a more or less reniform spot of pale depressed hairs which joins the apical spot along the lateral margin. Underparts finely punctured, metasternum with two carinæ which run outward and backward from the intermesocoxal process; surface of abdominal sternites between the punctures alutaceous. Coxæ, trochanters, and basal half of each femur pale, the rest piceous. Length, 7 to 11.5 millimeters.

Male.—Sixth abdominal sternite broadly, shallowly but angulately emarginate.

Female.—All abdominal sternites simple.

"East Mindanao" (type). BASILAN (*Baker 11541, 11542, 11873*). MINDANAO, Zamboanga Province, Zamboanga (*Baker 4274, 6698, 7292,* and other specimens); Dapitan (*Baker 11892, 12744,* and other specimens): Lanao Province, Iligan (*Baker 13518, 13519,* and other specimens): Surigao Province, Surigao (*Baker*). LUZON, Laguna Province, Mount Maquiling (*Baker 7289, 11539*); Los Baños (*Baker 1153*); Mount Banahao (*Baker*).

In the original description of *subfuscum,* Gorham mentions that only the basal segment of the antennæ is pale. In the material described above, the basal and second segments are pale. This discrepancy can be accounted for by the rather small size of the second segment and by its very close approximation to the first. Gorham also states that the postmedian band is nude. Under the low power this condition appears to obtain, but with higher powers a rather dense pile of short black hair appears. In other respects the material before me satisfies in every particular the description of Gorham.

Genus **DASYCEROCLERUS** Kuwert

Dasyceroclerus KUWERT, Ann. Soc. Ent. Belg. **38** (1894) 399 and 410; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 77; Col. Cat. (Junk) Cleridae (1910) 63.

Generic characters.—Clerinæ; head moderate, front between the eyes rather broad, eyes finely granulate and deeply triangularly emarginate, labrum bilobed; antennæ eleven-segmented, first segment large and stout, slightly bent, second short and

globular, third cylindrical, fourth to tenth of equal width and nearly equal length, eleventh oval, acuminate; terminal segment of maxillary palp cylindro-acuminate, that of labial palp dilated toward the obliquely truncated apex. Thorax longer than broad, sides feebly dilated, anterior coxal cavities open behind. Elytra parallel, covering the abdomen, punctures in rows. Abdomen with six visible sternites. Legs moderate, femora not especially swollen, tarsi with the second segment long, covering the first, claws with broad basal tooth.

Genotype, *Dasycerocierus viridis* Kuw.

Geographic range, Indo-Malayan Region, Australia, Africa.

The above characterization of the genus is drawn from a study of *D. cylindricus* (Westw.), a Bornean species. The only Philippine representative was recently described by Schenkling and, as it is unknown to me in nature, I give a free translation of his original description.

Dasycerocierus banksi Schenkling.

Dasycerocierus banksi SCHENKLING, Philip. Journ. Sci. § D 8 (1913) 304.

Yellow-brown, above with long black and white hairs intermingled, antennæ brown with the first two segments pale, elytra pale yellow with humeri, a spot on the basal margin, two postmedian transverse fasciæ, each composed of longitudinal spots placed in a row, and sometimes a subsutural spot just behind the scutellum black or brown. Punctures of elytra in rows, becoming obsolete behind the middle. Underparts of the thorax blackish, abdomen brownish yellow. Legs whitish yellow, the tips of the femora, and tarsi dark, anterior and middle tibiæ annulate at the middle of their length with dark. Length, 6 to 7 millimeters.

Sexual characters not mentioned.

PALAWAN, Bacuit. Type No. 12364 in the collection of the Bureau of Science, Manila.

McGregor, in his discussion of the zoögeographical regions of the Philippines based on the avifauna, has noted that Palawan shows a much closer relationship to Borneo than to other islands of the main group. In this connection it is of interest to note that the present genus is represented in Borneo by six recorded species, but has not been detected on any of the eastern or northern islands of the Philippine group by Professor Baker. Greater collecting activity on Palawan and Balabac will un-

doubtedly uncover many other species of Cleridæ having pronounced Bornean affinities.

Genus THALEROCNEMIS Lohde

Thalerocnemis LOHDE, Cat. Cler., Stett. Ent. Zeit. **61** (1900) 78; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 77.

Chlorocnemis KUWERT, Ann. Soc. Ent. Belg. **38** (1894) 399 and 417. (Preoccupied by *Chlorocnemis* Selys.)

Generic characters.—Clerinæ; form broad, depressed. Front moderately wide, eyes finely granulate, prominent, deeply and triangularly emarginate; labrum bilobed; antennæ eleven-segmented, filiform, first segment short and stout, second globular, about half as long as first, third to tenth elongate, each with from three to five long hairs, eleventh longer than tenth, acuminate; terminal segment of maxillary palp cylindro-acuminate, that of labial palp long, obliquely truncate. Thorax transverse, apical transverse impression feeble, basal impression distinct, sides dilated. Elytra gradually narrowed to tips, punctate-striate, intervals with a few coarse spinelike bristles which arise from simple punctures. Abdomen with six visible sternites, legs moderately long, femora swollen, tarsi with first segment short, concealed beneath the second, second long, claws long and slender with broad basal tooth.

In the males, the fifth and sixth segments may be modified and the claws of the anterior tarsi have much larger lobes than those of the middle or posterior tarsi.

Genotype, *Chlorocnemis tibiichloralis* Kuwert.

Geographic range, Malayan Region.

This genus, not previously reported from the Philippines, is closely related on the one hand to *Dasyceroclerus* (of which it is made a subgenus by Schenkling) and on the other to *Phaeocyclotomus*. It appears to me to be as worthy of generic rank as is either of the other two mentioned. Two representatives of the genus are known to me from the region under discussion, one from Luzon, the other from Mindanao and Basilan.

Key to Philippine species of Thalerocnemis Lohde.

Intermesocoxal process of mesosternum spatulate, its lateral margins carinate, the carinæ running forward halfway across the mesosternum, metapleuræ dark .... **T. variabilis** sp. nov.

Intermesocoxal process of mesosternum without carinæ, the lateral margins simply with bead which follows the margin of the coxal cavity, metapleuræ pale .... **T. bakeri** sp. nov.

Thalerocnemis variabilis sp. nov.

Robust; color piceous, entire insect clothed with short, depressed, yellowish white hairs, thorax and elytra with a few spines. Head between the eyes with a few scattered punctures, in front and behind more densely punctured, occiput slightly wrinkled, pubescence on epistoma and frons longer than on other parts of the body. Thorax broader than long, rather densely punctured, the punctures varying in size in different individuals, pubescence moderately dense, mostly directed toward the median line. Elytra with ten rows of punctures reaching almost to apex, the intervals moderately convex with very many fine punctures and with a few heavy spinelike bristles, the latter especially on the first, third, fifth, and ninth rows. Surface entirely covered with yellowish white hairs. From the seventh interval to the margin these hairs are directed outward; inside the seventh interval the hairs occur in patches in which the direction of the individual hairs alternates. At the base, just before the middle, at apical third and at apex, the hairs are directed toward the suture. Underparts finely and densely punctured, the surface between punctures alutaceous, pubescence fine and dense, especially on the thoracic sclerites. Legs, especially the posterior femora, stout, pale, the knees, tarsi, and part of the tibiæ dark. The dark markings on the tibiæ form rings in the paler-colored specimens, while in the deeper-colored ones the entire tibiæ may be involved. Length, 5 to 7 millimeters.

Male.—Fifth abdominal sternite broadly and shallowly emarginate, sixth less broadly and proportionately more deeply emarginate.

Female.—Abdominal sternites simple.

Type, a male from Butuan, Agusan Province, Mindanao (*Baker 4278*). Paratypes of both sexes from Basilan (*Baker 11871* and other specimens) and from the following localities on Mindanao: Dapitan (*Baker 12746* and other specimens), Zamboanga (*Baker 11544* and other specimens), Iligan (*Baker 12743* and other specimens), Surigao (*Baker*), Kolambugan (*Baker*), and Tangkulan (*Baker*).

There appears to be no way by which the material listed above can be separated into two or more valid species. For any character chosen, the material is easily segregated into two or more species, but those specimens which group themselves according to one character find themselves distributed among two or three "species" if some other character is selected as a

specific criterion. Furthermore, geographic distribution seems in no way to govern the variation. The sexual modification of the male abdomen is variable, but there again it is impossible to draw distinct boundaries.

Thalerocnemis bakeri sp. nov.

Form more elongate than in the preceding species. Head between the eyes rather sparsely, below eyes very densely, and on the occiput moderately densely punctured, epistoma densely punctured at sides, smooth and shining in the middle; antennæ with the terminal segment twice as long as the tenth, terminal segment of labial palp more than three times as long as its greatest width. Thorax very finely and densely punctured, except for the narrow median line and the flanks which are almost impunctate; the lateral foveæ are much less distinct than in the preceding. Elytra with the usual ten rows of punctures reaching to about apical fifth and from there continued to the apex in the form of grooves; spinelike bristles on the third, fifth, and ninth intervals; arrangement of pubescence as in *T. variabilis*. Underparts densely punctured, surface between punctures alutaceous. Legs moderate in length, femora swollen, pale, the knees and tarsi dark. Length, 6.5 to 7.5 millimeters.

Male.—Emargination of the sixth abdominal sternite about as wide as deep, subtriangular.

Female.—Segments with margins simple.

Type, a male from Mount Maquiling, Laguna Province, Luzon (*Baker 6083*). Paratypes, both sexes, from the following localities on Luzon: Mount Maquiling (*Baker 6080*), Los Baños (*Baker 572, 575, 1151*), Mount Banahao (*Baker*).

It is remarkable that the color of the metapleuræ should be of specific value. In not one of all the specimens of *T. variabilis* is there the least tendency toward pale coloration, even though the abdominal sternites may be either dark or light. On the other hand, the Luzon species always has pale metapleuræ, even when the abdomen is entirely dark.

Genus PHAEOCYCLOTOMUS Kuwert

Phaeocyclotomus KUWERT, Ann. Soc. Ent. Belg. **38** (1894) 400 and 420; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 79; Col. Cat. (Junk) Cleridae (1910) 66.

Generic characters.—Clerinæ; form depressed, tapering toward apex, head vertical, with eyes as wide as thorax, eyes

finely granulated, deeply emarginate, labrum deeply emarginate; antennæ eleven-segmented, first segment stout, somewhat bent, second short and broad, nearly spherical, third longer than first or any of the succeeding except the last, thin, fourth to tenth elongate-oval, flattened, each with a few erect bristlelike hairs, eleventh elongate-cultriform, not quite as long as ninth and tenth together. Terminal segment of maxillary palp short and thick, slightly tapering, truncate, that of labial palp elongate triangular, obliquely truncate. Thorax slightly broader than long, constricted at base, sides rounded, anterior coxal cavities open behind. Elytra acuminate at apex, with ten rows of coarse punctures on each, which become obsolete near middle. Abdomen with six visible sternites. Sexual modifications slight. Legs moderately long, tarsi five-segmented, basal segment short, situated beneath the elongate second, second to fourth with lamelliform processes beneath, fifth as long as third, claws with a broad basal tooth.

Genotype, *Phaeocyclotomus verrucosus* Kuwert.

A large genus of widely distributed and poorly defined forms. About seventy species have been described, from the Malay Archipelago, Australia, and Africa. A revision based on structural characters is greatly needed.

From the Philippines I am able to recognize but two distinct species, distinguished one from the other by the following characters:

Key to Philippine species of Phaeocyclotomus Kuwert.

Elytra with rows of quadrate punctures; tarsi concolorous with the tibiæ. **P. tapetum** (Gorham).

Elytra with rows of large clearly cut circular punctures; tarsi very dark or black.......... **P. nigripes** sp. nov.

Phaeocyclotomus tapetum (Gorham). Plate 2, fig. 12; Plate 3, fig. 23.

Stigmatium tapetum GORHAM, Cist. Ent. 2 (1876) (1875–1882) 95.

Form short and broad, strongly depressed. Head piceous, front below the eyes finely and densely punctured, with dense whitish pubescence, between the eyes and occipital regions sparsely punctured and rather sparsely pubescent; antennæ slightly paler than head, unicolorous, reaching to beyond the base of the pronotum. Pronotum piceous, broader than long, rather sparsely and finely punctured, moderately densely clothed with depressed whitish pubescence with a few erect dark hairs

intermingled; on the flanks there are numerous long white bristles; anterior transverse impression feeble, basal deep and distinct. Elytra piceous with a dark narrow transverse postmedian band, with rows of large quadrate punctures, the first seven of which extend to apical fourth, the last three are abbreviated and end at about the middle. The interspaces have a few stiff black spines irregularly arranged. Anterior to the dark transverse bar the pubescence is inconspicuous, short, depressed, and pale. Beyond the bar, for half the distance to the apex, the pubescence is very dense and white; apically it becomes somewhat sparser and is broken by a small subapical dark spot. Underparts of the thorax castaneous, of the abdomen reddish yellow. Femora pale yellowish white on basal half, dark apically, tibiæ and tarsi castaneous. Length, 6 to 8 millimeters.

Male.—Fifth and sixth abdominal sternites entire, transverse; terminal tergite rounded.

Female.—Fifth sternite and terminal tergite similar to male; sixth sternite rounded.

"Mindanao, Sarawak, Siam." Material before me as follows: MINDANAO, Davao Province, Davao (*Baker 7287, 7288*) : Zamboanga Province, Zamboanga (*Baker 7290*) : Lanao Province, Iligan (*Baker 13521*) : Surigao Province, Surigao (*Baker*). LUZON, Laguna Province, Mount Maquiling (*Baker 6079, 6081*). Specimens from Borneo do not appear to differ specifically from the Mindanao material.

Phaeocyclotomus nigripes sp. nov.

Form of *P. tapetum* (Gorham) but larger. Head similar to that of *tapetum* in color and sculpture. Pronotum more densely punctured, pubescence slightly denser, anterior transverse impression almost obsolete on disk. Elytra with rows of large circular punctures which become indistinct on the postmedian transverse dark fascia. Fascia about one-fifth of the elytral length in width (broader than in *tapetum*) situated just behind the middle; apical third of elytra covered with a dense vestiture of pale whitish pubescence which is broken by two small subapical dark spots on each elytron; basal half of elytra with mixed black and pale pubescence. Underparts of thorax piceous, of abdomen castaneous. Femora pale, apical half infuscate, tibiæ castaneous, tarsi black. Length, 11 millimeters.

Male.—Sixth abdominal sternite feebly emarginate. Otherwise as in *P. tapetum* (Gorham).

Female.—As in *P. tapetum* (Gorham).

Type, a male from Dapitan, Zamboanga Province, Mindanao (*Baker 11875*); paratypes, three females from the same locality.

I am unable to identify this species with any of those described by Kuwert. It appears to be quite local in distribution.

Genus STIGMATIUM Gray

Stigmatium GRAY, Griffith's Anim. Kingd., Ins. 1 (1832) 375; LACORDAIRE, Gen. Col. 4 (1857) 464; KUWERT, Ann. Soc. Ent. Belg. 38 (1894) 398 (revision); SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 44; Col. Cat. (Junk) Cleridae (1910) 60.

Generic characters.—Clerinæ; form robust, tapering gradually to the acute apices of the elytra. Head erect, front moderately wide, labrum deeply emarginate, almost bilobed, eyes deeply emarginate, finely granulate, antennæ eleven-segmented, first segment stout, slightly bent; second globular, third to tenth somewhat triangular, each shorter and broader than its predecessor, eleventh longer than tenth, cultriform; terminal segment of maxillary palp cylindrical, slightly acuminate, that of labial palp long, wider at apex which is obliquely truncate. Thorax almost equilateral, sides broadly rounded behind the anterior transverse impression, constricted at base, anterior coxal cavities narrowly open behind. Elytra covering abdomen, acutely narrowed at apex, basal half with coarse rasplike punctures in rows, apical half sometimes with traces of striæ, finely punctured. Abdomen with six visible ventral segments, legs moderately long, tarsi with second segment longer than third, claws with basal tooth.

Genotype, *Stigmatium cicindeloides* Gray.

Geographical distribution, Indo-Malaysia, Australia, Africa.

The Philippine representatives of this extensive genus may be distinguished by the following characters:

Key to Philippine species of Stigmatium Gray.

1. Rows of punctures of elytra continued to apex. **S. laterifoveatum** Kuwert.
   Rows of punctures end at or just behind the middle .... 2.
2. Abdomen black, thorax finely transversely wrinkled.... **S. bakeri** sp. nov.
   Abdomen red or brownish red .... 3.
3. Frons carinate between eyes, antennal segments 5 to 10 three times as long as broad .... **S. tuberculibase** Kuwert.
   Frons not carinate between eyes, antennal segments 5 to 10 not more than twice as long as broad .... 4.

4. Anteapical pubescence forming an irregular ring inclosing a reniform spot of black, no trace of transverse bars of pubescence at apical fourth .... S. sibuyanum sp. nov.
   Anteapical pubescence forming a solid spot except for minute nude points; at apical fourth there is a transverse bar of pubescence reaching from margin halfway across each elytron.
   S. philippinarum Gorham.

Stigmatium philippinarum Gorham.

Stigmatium philippinarum GORHAM, Cist. Ent. 2 (1876) (1875–1882) 93.

? *Stigmatium amboinae* KUWERT, Ann. Soc. Ent. Belg. 38 (1894) 406 and 438; SCHENKLING, Col. Cat. (Junk) Cleridae (1910) 62.

Form robust, sides parallel to about middle of length of elytra whence they taper gradually to an acutely pointed apex. Color castaneous brown above, underparts and basal portion of femora pale brownish red. Head very finely and very sparsely punctured, with a few scattered hairs about the eyes. Thorax slightly longer than broad, sides somewhat dilated, anterior transverse impression rather feeble throughout, especially so on the disk, surface very finely punctured, highly polished. Scutellum conspicuously clothed with white hairs. Elytra with nine rows of coarse pitlike punctures on basal half, the ninth row (submarginal) being incomplete, the first five interspaces with a few setiferous pustules in each, the first interspace on each elytron wide and with the suture depressed below the surrounding surface to just beyond the end of the rows of punctures; the third and fourth puncture rows longer than any of the others; apical half of elytra very finely and rather densely punctured, with dark, depressed pubescence; basal half of each elytron, a marginal spot at apical fourth which extends halfway across the elytron toward the suture, and the apices are clothed with longer, whitish pubescence. Underparts very finely and densely punctured. Basal half of femora and tibiæ pale, the rest of the legs dark. Pubescence of underparts white. Length, 10 to 15 millimeters.

Male.—Sixth sternite with a broad and very shallow emargination at tip.

Female.—Fifth sternite with a deep and narrow, almost rectangular emargination, sixth sternite rounded.

LUZON, Laguna Province, Mount Maquiling (*Baker 12738*); Mount Banahao (*Baker 2407*): Bataan Province, Mount Limay (*Baker 2336*). "North Luzon."

The type of this species was noted by Gorham as from Luzon.

Stigmatium sibuyanum sp. nov.

Form and size of *S. philippinarum* Gorham. Color deep piceous, metathorax, abdomen, and legs (except tarsi which are dark) castaneous. Head finely and rather sparsely punctured, tumulate between the eyes, sparsely clothed, especially about the eyes, with rather long white hairs. Thorax slightly broader than long, finely and closely punctured and finely alutaceous, sides and base with a few long whitish hairs, rest of surface with short black depressed pubescence. Sides moderately dilated, round, anterior transverse impression shallow but complete across disk, basal impression deep and distinct. Scutellum densely clothed with whitish hairs. Elytra with nine rows of rasplike punctures on basal half, the third row longer than any of the others, first five interspaces with setiferous pustules, sutural region depressed as in *S. philippinarum,* apical half of elytra very densely and minutely punctured. There is a median transverse band of yellowish white hairs which is irregular on the posterior margin, becoming wider between the third puncture row and the suture. In front of this band the surface covered by the rasplike punctures is sparsely set with similar yellowish white hairs. On about the apical fourth of each elytron there is an irregular ring of yellowish hairs inclosing a reniform black spot, the concavity of which is directed toward the apex of the elytron. The portion of this ring which connects the lateral margin with the suture is angulate at its middle, sending a triangular offshoot toward the base of the elytron. Underparts and legs finely, densely, and regularly punctured, sparsely clothed with short, depressed white hairs. Length, 10 to 15 millimeters.

Male.—Fifth sternite evenly and shallowly emarginate from side to side; sixth sternite almost truncate, feebly emarginate at apex.

Female.—Fifth sternite deeply triangularly emarginate, the emargination deeper than half the width of the segment; sixth sternite rounded.

Type, a female from Sibuyan (*Baker 18587*) ; paratype, a male from the same place.

Easily separated from either *S. philippinarum* Gorham or *S. bakeri* sp. nov. by the character of the thoracic sculpture and elytral pattern.

Stigmatium bakeri sp. nov. Plate 2, fig. 13.

Color deep castaneous brown, basal half of elytra lighter. Head finely and very densely punctured behind the eyes, less densely between them, epistomal region with a few coarse punctures at sides, conspicuous pubescence restricted to the margins of eyes and on clypeus. Thorax broader than long, especially so in male; sides much swollen behind the anterior transverse impression, which is almost obsolete across the disk; basal impression very deep and clearly defined; surface very finely transversely wrinkled with a few distinct punctures at the sides; pubescence of disk short and ferrugineous, that of flanks longer and whitish. Scutellum densely clothed with whitish hairs. Elytra each with eight rows of pitlike punctures extending to about the middle of the length, the margin of each pit raised on the side toward the base of the elytron, rasplike; in the third and fifth interspaces, near the base, there are a few setigerous pustules; in the apical half, the punctures are very fine and dense; basal half almost entirely covered with depressed whitish pubescence; a small transversely oval spot at apical fourth, common to both elytra, a short, transverse, sometimes sinuate bar on lateral margin, also at apical fourth, and the apices also whitish pubescent; the rest of the elytra covered with a very fine, dark pile that is almost invisible. Underparts very dark with bluish reflections, sparsely clothed with white hairs. Femora with undersides blackish, upper sides pale brown, tibiæ pale brown, tarsi blackish. Length, 9.5 to 12.5 millimeters.

Male.—Pronotum very transverse; elytral humeri prominent; fifth and sixth sternites very broadly and shallowly emarginate; terminal tergite rounded.

Female.—Pronotum slightly broader than long; elytral humeri not conspicuously prominent; fifth sternite with a broad emargination which is of uniform depth across the median portion of sternite; terminal tergite and sternite simple, rounded.

Type, a male from Port Banga, Zamboanga Province, Mindanao. Paratypes of both sexes from various localities on Mindanao as follows: One female from Iligan (*Baker 12739*), one female from Zamboanga (*Baker 7286*), one female from Kolambugan (*Baker 13517*), twenty-one males and fifteen females from Port Banga, one male and one female from Mu-

mungan, five males and four females from Surigao, and seven males from Kolambugan. The type and specimens not credited to Professor Baker were received from Staudinger and Bang-Haas.

Stigmatium encaustum Gorham.

Stigmatium encaustum GORHAM, Cist. Ent. 2 (1876) (1875–1882) 93.

In the original description of this species, Gorham gives only two differential characters to separate it from *S. philippinarum* Gorh. These are (1) that the flattened portion of the elytra is even more distinctly depressed than in *philippinarum* and (2) that the species is conspicuously less pubescent than *philippinarum.* It is apparent that the first character to a certain extent depends upon the second, for the presence of pubescence tends to conceal depressions and elevations. There is before me a badly rubbed specimen of *philippinarum,* which fits the description of *encaustum* well; it is, however, from Luzon, while the type of *encaustum* was said to be from Bohol. As I have seen no material of this genus from Bohol, I am forced to allow the name to stand, though I believe that the two species are synonymous.

Stigmatium tuberculibase Kuwert.

Stigmatium tuberculibase KUWERT, Ann. Soc. Ent. Belg. 38 (1894) 442.

This species, originally described from Borneo, is reported from the Philippine Islands by Schultze.[4] For this reason it is included in the key though I have seen nothing resembling it from the Islands.

Stigmatium laterifoveatum Kuwert.

Stigmatium laterifoveatum KUWERT, Ann. Soc. Ent. Belg. 38 (1894) 440.

Schenkling[5] has reported this species from the Philippine Islands. Its type locality is Amboina, an island whose fauna is in general more closely allied to that of Celebes than to that of the Philippines.

[4] Philip. Journ. Sci. § D 11 (1916) 46.
[5] Col. Cat. (Junk) Cleridae (1910).

Stigmatium mastersi MacLeay.

Stigmatium mastersi MACLEAY, Trans. Ent. Soc. N. S. Wales 2 (1872) (1869–1873) 269.

It is inconceivable that this Queensland species should be found in the Philippines. It would best be removed from the list until further proof of its occurrence is offered.

Genus COPTOCLERUS novum

Generic characters.—Clerinæ of small size. Front broad, eyes not very prominent, finely granulate, with a V-shaped emargination, labrum deeply emarginate; antennæ short, eleven-segmented, first segment thick, slightly bent, second slightly longer than broad, globular, third to fourth or third to fifth cylindrical, each about twice as long as broad, sixth or seventh to tenth subtriangular, and equal in length, each broader than the one preceding, eleventh cultriform (from equal to to twice as long as the tenth) ; terminal segment of maxillary palp cylindrical, slightly acuminate, sometimes subulate, that of labial palp broadly dilated toward tip and obliquely truncate. Thorax depressed, usually distinctly transverse, constricted at base, anterior transverse impression shallow, anterior coxal cavities open behind, often with a pronounced lateral cariniform margin. Elytra long, covering the abdomen, rounded or somewhat pointed behind, punctate-striate in basal half, rows of punctures continued toward apex in form of shallow grooves. Abdomen with six visible sternites. Legs moderately long, femora not swollen, tarsi with first segment very short, second the longest of all, claws with rather broad basal tooth.

Genotype, *Coptoclerus sericeus* sp. nov.

Geographic range, probably over the Indo-Malayan Region.

This new genus is erected to include eleven species of rather small clerids which do not appear to fit into any heretofore described genus. They are among the smallest of the true Clerinæ known to me. Of the eleven, nine are from the Philippine Islands. As the arrangement of the pubescence upon the elytra seems to offer the best means of separation, the following key emphasizes that character.

It is of considerable interest to note that in many of the species included there is a pronounced, sharply defined lateral

carina, passing beneath the lateral dilation of the thorax and strictly homologous with the lateral margin of the Enopliinæ and Korynetinæ. There is at least a trace of the carina in all species, but it reaches its greatest development in *C. obliquus*. It has been apparent to me for some time that there is no clean-cut division of this family into two subfamilies, to say nothing of two families. Some recent writers have attempted the latter division, but with little success. Even a division into seven tribes or subfamilies as here attempted fails in a few instances such as the present, but is on the whole tolerable.

Key to Philippine species of Coptoclerus g. nov.

1. Pubescence on elytra in clear-cut lines or spots forming a definite pattern .... 2.
   Pubescence on elytra in irregular patches of indefinite extent........ 7.
2. Black; suture not conspicuously pubescent throughout its length.... 3.
   Piceous, castaneous, or pale brown, never coal black; suture throughout its length narrowly bordered with white pubescence........ 4.
3. Each elytron with a triangular spot of white silky pubescence toward the lateral margin just before the middle........ **C. binotatus** sp. nov.
   Each elytron with an undulating median crossbar, subapical transverse spot starting at the margin and reaching halfway to suture, and apices broadly covered with white pubescence..... **C. fasciatus** sp. nov.
4. Each elytron with an almost equilateral triangle of white pubescence on the basal half, one side of which lies along the suture and with the opposite angle in the sixth interval, also with a short posthumeral bar lying in the ninth interval, a subapical undulating transverse bar and the apical margin clothed with white pubescence. **C. triangularis** sp. nov.
   Pubescence not as above........ 5.
5. Puncture rows very short, hardly reaching beyond the basal fourth; elytra with the scutellar region, an antemedian transverse spot near the margin, a median transverse spot of similar size and shape across the suture, a subapical lunate crossbar with the convexity toward the base on each, and the apical margin of each sparsely clothed with short white hairs........ **C. intricatus** sp. nov.
   Puncture rows continued to beyond the basal half; pubescence not as above .... 6.
6. Each elytron with short white pubescence as follows: The scutellar region, a narrow oblique bar reaching from the suture just behind the scutellum to the eighth interval at the middle of the length of the elytron; a second and much shorter bar crosses this near its outer extremity, is oblique in the opposite direction and reaches from the ninth to the third row of punctures; at the apical fourth a transverse rectangle across the suture which is connected with the lateral margins at its posterior corners and the apices except for a denuded C-shaped spot on each; emargination of eyes large. **C. obliquus** sp. nov.

Elytra with an X-shaped mark of white hairs across the suture in the basal half, the lower points of the design touching the apices of triangles whose bases are on the lateral margins, these also of white hairs; the apices are covered, except for a large "V" and two small spots on each, with white hairs; eyes with small emargination.
C. albipictus sp. nov.

7. Thorax distinctly wider across middle than at anterior margin, puncture rows extending to beyond the middle of the length of the elytra, apical third and an irregular spot on outer half of width just before the middle more conspicuously pubescent than the rest.
C. apicalis sp. nov.

Thorax with sides straight, anterior transverse impression feeble, width of thorax across middle not greater than across anterior margin.... 8.

8. Puncture rows on elytra extending to beyond middle of length; elytra light brown, each with a piceous spot inclosing the humeral callosity and extending to about basal half and with five small irregular piceous spots on apical half, the light brown areas more densely pubescent than the dark.. **C. variegatus sp. nov.**

Puncture rows not reaching the middle of the length, except toward the lateral margins; elytra entirely piceous or nearly so; pubescence rather evenly distributed over entire surface but with the hairs directed partly toward and partly away from the suture... **C. sericeus sp. nov.**

Coptoclerus binotatus sp. nov.

Form elongate, parallel, depressed. Color black, antennæ piceous with the first and eleventh segments paler, palpi pale. Head finely and sparsely punctured, sparsely clothed with moderately long white hairs. Thorax slightly longer than broad (25–20), surface regularly covered with small granulations, from each of which a hair arises; the anterior transverse impression fails completely across the disk and is very feeble at the sides; along the flanks there are a few long and very stout spines, those nearest the base white; a few subdepressed white hairs on the disk near the basal margin. Elytra long, parallel, suture closed, covering the abdomen completely, with rows of large coarse punctures reaching beyond the middle, the intervals densely punctulate; just before the middle of the length and toward the lateral margin there is a triangular spot of white silky hair, one point of which is on the lateral margin, the other two in and toward the base; except for an ante-apical transverse bar, the upper surface is covered with short gray pubescence. Underparts shining, finely and sparsely punctured, flanks of metathorax clothed with silky hair. Legs black, finely punctured, somewhat rough, tarsi slightly paler. Length, 4 to 6 millimeters.

Type, a male from Mumungan, Lanao Province, Mindanao. Paratypes: Eighty-three specimens, males and females, from Mumungan; one male from Surigao, Surigao Province (*Baker*); and one male from Davao, Davao Province (*Baker 7280*). The specimens from Mumungan were received from Staudinger and Bang-Haas.

Coptoclerus fasciatus sp. nov.

Form elongate, parallel, depressed. Head very finely and sparsely punctured, shining, front wide, eyes with rather small emargination. Antennæ with terminal segment almost as long as ninth and tenth together. Thorax slightly longer than broad, polished, very finely and sparsely granulate, anterior transverse impression rather deep, sparsely clothed with fine depressed white hairs, flanks with a few bristles. Elytra with rows of punctures extending to apical fourth, the first three rows shorter than the fourth or fifth, surface between punctures granulate, with short depressed hairs both black and white. White pubescence as described in key; however, occasionally the apical pubescence merges with that of the subapical transverse spot. The two may be distinguished because the hairs are much less dense on the apices than on the spots. Underparts alutaceous, finely and sparsely punctured, sparsely pubescent. Femora sparsely punctured, tibiæ rough, tarsi rather long. Length, 4 to 6 millimeters.

Male.—Terminal tergite enormously developed, resembling that of *Operculiphorus tubifer* Kuwert.

Female.—No apparent modifications of the abdominal sclerites.

Type, a male from Kolambugan, Lanao Province, Mindanao. Paratypes: Four specimens from Kolambugan (one of which is *Baker 13514*); four specimens from Port Banga, Zamboanga Province, two from Tangkulan, Bukidnon Province (*Baker 14662*); one from Dapitan, Zamboanga Province; and four from Basilan. Type and ten paratypes received from Staudinger and Bang-Haas.

It might be mentioned here that *Stigmatium ? iodinum* Gorham is apparently closely related to this section of the genus and should be transferred to *Coptoclerus.*

Coptoclerus triangularis sp. nov.

Form parallel, depressed, about three times as long as wide. Color piceous, flanks of thorax darker, palpi, legs (except for the apices of the femora and the tibiæ which are dark) pale.

Front wide, head shining, finely and sparsely punctured, set with a few depressed white and erect black hairs; antennæ with terminal segment as broad as long, almost circular. Thorax equilateral or nearly so, anterior transverse impression feeble, disk smooth and shining with a few fine punctures, lateral portions much more densely punctured and rather thickly clothed with suberect pale hairs; lateral margins with a few pale bristles. Elytra with rows of coarse punctures extending beyond middle of length, surface between the coarse punctures densely punctulate, clothed with fine black hairs evenly distributed over entire surface and with a pattern of white hairs as described in key; also a few pale bristles scattered over the surface. Underparts alutaceous, moderately densely punctured; first and most of second sternite pale. Legs finely punctured. Length, 3.7 millimeters.

Type, a specimen, apparently a female, from Baguio, Benguet Subprovince, Luzon (*Baker 6078*).

The fifth sternite is very broadly and shallowly emarginate; the sixth is rounded, as wide as the terminal dorsal segment. Purely from analogy, I assume it to be a female. There is no trace of the internal genitalia.

Coptoclerus intricatus sp. nov.

Form depressed, cylindrical, the elytra subacute at their apices. Color deep piceous, the terminal segment of labial palpi, coxæ, trochanters, and basal two-thirds of femora pale. Head shining, front wide, finely and sparsely punctulate except for two circular areas rather low down which are densely and rather more coarsely punctured, antennæ with the tenth and eleventh segments hardly separable, together forming an oval disk, terminal segment of labial palp shorter and broader than in the genotype. Thorax transverse, finely and sparsely punctured, sparsely pubescent with short suberect white hairs. Elytra with rows of punctures becoming obsolete at about basal third; beyond this there is scarcely a trace of striæ, the surface covered with very minute granules; from the center of each arises a short black hair; white pubescence as described in key. Underparts black, shining, the abdominal sternites very finely transversely strigose and sparsely punctured. Legs finely punctured, color as described above, tarsi rather short, the second segment but little longer than the third. Length, 3.2 millimeters.

Type, a specimen, sex uncertain, from Sibuyan (*Baker 18584*). There appears to be a total absence of sexual modification of the abdominal sternites.

Coptoclerus obliquus sp. nov.

Form rather robust, parallel. Size large for the genus. Color pale brown, thorax and elytra variegated with piceous, legs with the basal half of the femora yellow, the rest darker. Head with front broad, polished, finely and sparsely punctured, the region in front of the line connecting the ocular emarginations and a small round spot just above each eye densely clothed with white silky hairs, antennæ dark except for the basal segment and the apical half of the eleventh, which are pale. Thorax slightly broader than long, finely and rather densely punctured, the apical margin very slightly roughened, lateral cariniform margin distinct, the flanks low down impunctate and highly polished; flanks, two large longitudinal discal spots, and a small roundish spot on each side of the disk piceous; pubescence pale and depressed, with a few erect bristles scattered over the surface. Elytra with rows of coarse punctures reaching to about apical fourth, surface between punctures and at apex minutely granulate, a short black or brown hair arising from each granule; white pubescence as described in key. Underparts alutaceous, finely and rather sparsely punctured. Legs finely punctured. Length, 5.3 millimeters.

Male.—Terminal abdominal tergite large, embracing the small terminal sternite, its edges rolled down and furnished with a small sharp chitinous thorn on either side.

Female.—Abdominal segments unmodified.

Type, a male from northern Luzon, sent me by Dr. K. Jordan of the Tring Museum; paratype, a female from Los Baños, Laguna Province, Luzon (*Baker 573*).

Coptoclerus albipictus sp. nov.

From robust, hardly depressed. Color piceous, legs, especially the basal halves of the femora and tarsi, pale. Head with front wide, finely and sparsely granulate, sparsely clothed with depressed white hairs, eyes rather minutely emarginate, almost as in the Hydnocerinæ; terminal segment of maxillary palp elongate-conical. Thorax with the anterior transverse impression feeble, sides nearly parallel, surface sparsely and finely granulate, sparsely clothed with depressed white hairs. Elytra with rows of large punctures extending to about apical fifth,

interspaces and apices densely and minutely granulate, densely clothed with short erect brown hairs; white pubescence as described in key. Underparts alutaceous, the mesopleuræ with a few very large pits in lieu of punctures, the rest finely and sparsely punctured. Legs finely punctured, hind tibiæ without longitudinal carina. Tarsi rather long, claws slender with broad basal tooth. Length, 3 millimeters.

Male.—Fifth sternite broadly and shallowly emarginate.

Female.—Unknown.

Type, a male from Surigao, Surigao Province, Mindanao (*Baker*).

This species is the least depressed of all those that I have included in the genus. It has somewhat the form of the scolytid *Chramesus icoriae* or, to a less extent, that of a *Scolytus*. I have seen but one specimen.

Coptoclerus apicalis sp. nov.

Form parallel, depressed. Head minutely and sparsely punctured, punctures denser behind eyes; antennæ with the terminal segment as long as the ninth and tenth taken together; last segment of labial palp twice as long as breadth at widest part. Thorax transverse, widest just in front of the middle, anterior transverse impression distinct, surface sparsely set with fine granules, sparsely pubescent with depressed pale hairs; a few bristles scattered over the surface, especially on the flanks; anterior margin narrowly pale. Elytra with the rows of punctures reaching to apical third, surface between punctures very finely granulate, a short hair arising from each granule; bristles, similar to those on thorax, occur at frequent intervals; the pale pubescence on apical third directed outward, from suture toward lateral margin, that of the antemedian spot directed inward toward suture. Underparts alutaceous, finely and rather sparsely punctured. Legs finely punctured, anterior and middle femora pale with a dark blotch of indefinite extent on the upper side, posterior femora with basal half pale, rest of legs piceous; tarsal claws rather long and slender. Length, 4 millimeters.

Male.—Fifth abdominal sternite shallowly and broadly emarginate; sixth sternite rather small, rounded; terminal dorsal segment large, rounded, edge slightly thickened.

Female.—Unknown.

Type, a male from Dapitan, Zamboanga Province, Mindanao (*Baker 12747*).

In shape of thorax this species is more closely related to *C. fasciatus* than to *C. sericeus*, which it more closely resembles superficially.

Coptoclerus variegatus sp. nov.

Form depressed, sides parallel to apical fourth of elytra, thence gradually narrowed to the acute apex. Color pale brown, variegated with piceous. Head broad in front, finely, sparsely, and evenly punctured, sparsely clothed with suberect pale hairs; tenth and eleventh segments of antennæ closely united, eleventh longer than tenth, together forming an oval plate; palpi testaceous. Thorax distinctly transverse, sparsely covered with minute granules, a short depressed hair arising from each granule; median line distinctly less granulate than sides; anterior transverse impression feeble; pale brown, an elongate median spot just before the base and the flanks behind the anterior impression piceous. Elytra with rows of punctures running slightly beyond the middle, the first four intervals much (about twice) broader than the rest, fifth and sixth puncture rows the longest, reaching to apical fourth; apices with traces of striæ, surface between large punctures of rows and of apices very finely punctulate, piceous markings as described in key; light brown areas with depressed pale pubescence. Underparts alutaceous, sparsely and finely punctured. Legs testaceous, partly clouded with dark; tarsi rather short, claws with tooth broader and with apical portion more nearly at right angles to basal portion than usual. Length, 4 millimeters.

Type, a specimen, sex uncertain, from Dapitan, Zamboanga Province, Mindanao (*Baker*).

In this species the postscutellar region is distinctly depressed below the level of the humeri. The specimen before me has the hind margins of all abdominal sternites entire. It is, I believe, a female.

Coptoclerus sericeus sp. nov. Plate 2, fig. 14.

Form depressed, parallel, obtusely pointed behind. Head with front wide, very finely and sparsely punctured, sparsely clothed with pale depressed hairs, these more or less segregated in patches at the inside of the eyes, the center of the front, and the clypeal region; antennæ with the last five segments wider than the preceding, seventh to tenth nearly equal in size and shape, eleventh twice the length of tenth, narrowly cultriform. Thorax transverse, anterior transverse impression feeble, sur-

face shining, very finely and sparsely punctured, the punctures absent from a broad median longitudinal stripe; pubescence sparse and depressed. Elytra with rows of punctures reaching slightly postmedian, the fifth and sixth rows the longest, second interval wider than the first or third, third and fourth equal and each wider than any of the rest; the conspicuous pubescence on the elytra is arranged in a spot, subbasal and halfway between the suture and margin, a broad V, common to both elytra, the apex of which is on the suture slightly postmedian and the upper ends on the sixth row of punctures at about basal fourth. Behind this band is an undulating bar somewhat M-shaped, situated on the apical fourth. The remaining surface of the elytra is covered with fine, depressed dark hairs with a few scattered bristles, the fine hairs arising from very small granules. Underparts alutaceous, rather more densely punctured at sides than at middle. Legs pale, the knees slightly darker; tarsi pale, rather short and stout. Length, 4 millimeters.

Male.—Fifth abdominal sternite broadly and shallowly emarginate; sixth sternite and terminal dorsal rounded.

Female.—Sternites apparently unmodified.

Type, a male from Dapitan, Zamboanga Province, Mindanao; paratypes from Basilan and from Iligan and Surigao on Mindanao. All collected by Professor Baker.

Subfamilia THANEROCLERINÆ nova

Subfamily characters.—Cleridæ; head moderately large, epistoma not separated from frons by distinct suture, clypeo-frontal suture low down, labrum very small, emarginate; eyes convex and prominent, in the Philippine genera coarsely granulate, almost entire, antennæ eleven-segmented, intermediate segments moniliform. Thorax often with a poorly defined lateral cariniform margin, pronotum constricted at base, discal punctures oval, anterior coxal cavities narrowly open or closed externally. Elytra rounded behind, punctured irregularly or in distinct rows. Abdomen with the first sternite longer than the second, with sixth sternite very small, often concealed by fifth, first as long as second and third together. Legs short, femora usually stout, tarsi five-segmented, first four segments short, of the anterior tarsi very broadly dilated, fifth segment long, claws simple or with a poorly developed basal tooth.

The very broadly dilated anterior tarsi, the almost entire eyes, and the peculiar form of the cephalic and pronotal punctures serve to distinguish a small group of genera from the rest of the family. Of the genera which I assign to this subfamily, two

are found in the Philippines. These are *Thaneroclerus* Lef. and *Cyrtinoclerus* g. nov. A third is *Lyctosoma* Lewis, based on a single Japanese species; a fourth, *Neoclerus* Lewis, which was based on a Japanese species but now contains three other species from the Malayan Region. Both of these genera may be collected in the region under discussion. Two American genera, *Ababa* Csy. and *Zenodosus* Wolc., also belong here.

An additional reason for establishing the new subfamily is found in the structure of the larvæ. In their work on the larvæ of the North American Cleridæ, Böving and Champlain have shown that the larvæ of *Thaneroclerus* and of *Zenodosus* differ from all known clerid larvæ in possessing a well-developed though short epicranial suture.

Key to the Philippine genera of Thaneroclerinæ.

1. Elytra irregularly punctured, terminal segment of maxillary palp more than twice as long as broad; lateral cariniform margin of thorax distinct............ Thaneroclerus Lefebvre.
2. Elytra with even and regular rows of elongate punctures; terminal segment of maxillary palp about as broad as long; lateral cariniform margin of thorax obsolete............ Cyrtinoclerus g. nov.

Genus THANEROCLERUS Lefebvre

Thaneroclerus LEFEBVRE, Bull. Soc. Ent. France 7 (1838) 13; SPINOLA, Rev. Zool. (1841) 73; Monog. Clérites 1 (1844) 205; KLUG, Clerii (1842) 309; LACORDAIRE, Gen. Col. 4 (1857) 449; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 53; Col. Cat. (Junk) Cleridae (1910) 75; GAHAN, Ann. & Mag. Nat. Hist. VIII 5 (1910) 63.
Isoclerus LEWIS, Ann. & Mag. Nat. Hist. VI 10 (1892) 191.
Thaneclerus CHENU, Encycl. d'Hist. Nat. Col. 2 (1860) 247.
Thanateroclerus GEMMINGER and HAROLD, Cat. Col. 6 (1869) 1739.

Generic characters.—Thaneroclerinæ; head moderately large, eyes oval, convex, virtually entire, coarsely granulate; antennæ eleven-segmented, first segment stout and short, second to eighth subequal, short, moniliform, ninth and tenth subequal, wider than any of the preceding though but slightly longer, eleventh oval, as wide as tenth and almost as long as ninth and tenth together, the last three segments forming an oval club; terminal segment of maxillary palp cylindro-acuminate, that of labial palp broadly triangular with the apical margin rounded. Pronotum with distinct lateral cariniform margin, sides in front of middle parallel, posterior half rapidly narrowed to base, anterior coxal cavities very narrowly open behind. Elytra covering the abdomen, irregularly punctured, together rounded at apex. Abdomen with the sixth sternite very small, usually

concealed by fifth. Legs rather short, femora stout, claws simple.

Genotype, *Thaneroclerus buqueti* (Lefebvre).

Except for *T. girodi* Chevr. from the West Indies and southern United States and *T. dermestoides* Klug from Arabia, the species of this genus are Indo-Malayan. But one has been taken in the Philippines.

Thaneroclerus buqueti (Lefebvre).

Clerus buquet LEFEBVRE, Ann. Soc. Ent. France 4 (1835) 577, pl. 16, fig. 4.

Thaneroclerus buqueti WESTWOOD, Bull. Soc. Ent. France 8 (1838) 13; KLUG, Clerii (1842) 310; SPINOLA, Monog. Clérites 1 (1844) 207; GAHAN, Ann. & Mag. Nat. Hist. VIII 5 (1910) 63.

Form oblong, depressed. Entire insect except for eyes castaneous. Head rather large, front with elongate punctures, vertex and occiput with round punctures, finely alutaceous, eyes quite prominent, antennæ reaching almost to base of pronotum. Pronotum longer than wide with anterior transverse impression entirely absent, basal impression deep and distinct, upper surface evenly, coarsely, and moderately densely punctured, the punctures oval, flanks below lateral cariniform margin sparsely punctured, alutaceous. Elytra irregularly, moderately densely and coarsely set with oval punctures, pubescence sparse and erect, sutural and lateral margins finely beaded. Underparts of thorax very coarsely punctured, abdomen rather finely so, metasternum deeply excavate in the middle of the posterior margin to receive the intercoxal process of the first abdominal sternite. Legs short, femora rather finely, tibiæ coarsely punctured. External sexual modifications apparently absent. Length, 5 millimeters.

"Bengal?" Los Baños, Laguna Province, Luzon (*Baker 11869*). Manila.

This is almost certainly the species of "Clerid" mentioned by Jones [6] in his work on the cigarette beetle in the Philippines. The habits described are nearly identical with those of the very closely related *Thaneroclerus girodi* Chevr. in the West Indies and Florida.

Genus CYRTINOCLERUS novum

Generic characters.—Thaneroclerinæ; head rather small, eyes oval, virtually entire, rather finely granulate; antennæ eleven-

[6] Philip. Journ. Sci. § D 8 (1913) 10.

segmented, first segment short and stout, second nearly as long as third, obconical, third to seventh subequal in length, eighth as wide as but shorter than seventh, ninth twice as wide as eighth and somewhat longer, tenth and eleventh mutually equal in width, wider than ninth, eleventh twice as long as tenth, round at tip; terminal segment of maxillary palp short and stout, equilateral, that of labial palp broadly triangular, truncate at tip. Prothorax longer than broad, widest anteriorly, strongly narrowed from anterior margin to base, anterior coxal cavities closed externally. Elytra covering the abdomen, with seriate punctures, the puncture rows near the suture somewhat confused. Abdomen with the sixth sternite very small, almost entirely concealed by the fifth. Legs short, femora swollen, tarsi with the fourth segment shorter than second or third, claws simple.

Genotype, *Cyrtinoclerus cyrtinoides* sp. nov.

Known only from Basilan. The resemblance which this genus bears to *Cyrtinus*, of the Cerambycidæ, has suggested the name. In the seriate punctuations of the elytra it differs from its nearest relatives, *Neoclerus* and *Ababa*.

Cyrtinoclerus cyrtinoides sp. nov. Plate 1, fig. 6.

Form oblong, cylindrical. Color dark piceous, almost black, except for the basal segments of the antennæ, the palpi, legs, and a transverse ill-defined marking in front of the middle of the elytra, which are paler. Head finely alutaceous, rather densely and coarsely punctured, the punctures elongate-oval; pubescence very sparse, silvery. Thorax longer than wide, in the form of a truncated cone, its greatest diameter at the anterior margin, basal diameter a little more than one-half of that, punctures deep and coarse, rather sparsely distributed, those on disk elongate, those on flanks polygonal, closely crowded together, pubescence fine, erect, sparse, silvery. Scutellum very small. Elytra with lateral margins parallel to apical third, thence evenly curved to suture at apex, with apparently twelve rows of punctures, the rows nearest the suture somewhat irregular. Elytra transversely depressed at basal fourth, the pale mark extends from the lateral margin across the elytron, just posterior to the depression, almost to the suture, where it curves anteriorly and completes a semicircle, ending at about the fifth row of punctures just behind the base of the elytron; basal sixth of suture also pale; the lighter portions of the elytra more or less densely clothed with short erect silvery hairs; there is

also a narrow anteapical bar of the silvery hairs, otherwise the pubescence is sparse, erect, and dark. Underparts, especially the metasternum, coarsely and sparsely punctured. First abdominal sternite as long as the next three together. Femora very stout. Length, 3 millimeters.

Type, a specimen, sex undetermined, from Basilan (*Baker*).

The depressed portion of the elytra with the covering of silvery hair gives this insect a somewhat myrmecoid appearance. In this respect it is quite different from the other members of this subfamily with which I am acquainted.

ENOPLIINÆ

Subfamily characters.—Cleridæ; eyes deeply and broadly emarginate anteriorly, antennæ ten- or eleven-segmented (in the Philippine genera), serrate or with the terminal segments elongate and forming a loose club. Thorax never greatly elongate, with distinct lateral cariniform margins; anterior coxal cavities open behind. Elytra almost or quite covering abdomen. Abdomen with six visible ventral segments; in some genera secondary sex characters occur on the abdominal segments. Legs rather short, tarsi with the fourth segment very small and included between the lobes of the third, first or basal segment as long as or longer than the second, claws with broad basal tooth.

At present, there are five genera belonging to this subfamily known to me from the Philippine Islands, two of which appear to be moderately rich in species. They can be distinguished one from another by the following characters:

Key to the known Philippine genera of Enopliinæ.

1. Form hemispherical, coccinelliform; pecten absent.. **Allochotes** Westwood.
   Form elongate, cylindrical; pecten sometimes present............................ 2.
2. Antennæ serrate, segments 4 to 11 subequal; pecten present................ 3.
   Antennæ with the terminal three segments greatly elongate, together greatly exceeding in length the rest of the segments combined; pecten absent.. 4.
3. Third antennal segment triangular, similar in shape to fourth; abdominal segments other than fifth and sixth of males carrying secondary sexual modifications.. **Teneroides** Gahan.
   Third antennal segment cylindrical, different in shape from fourth; abdominal segments (excepting fifth and sixth) without modifications in males.. **Tenerus** Castelnau.
4. Antennæ ten-segmented, tarsal claws simple, gular sclerite not reduced in size.. **Teneropsis** g. nov.
   Antennæ eleven-segmented, tarsal claws with a broad basal tooth, gular sclerite very small.. **Paratenerus** g. nov.

It has seemed best to create two new genera for two species which are both close to *Teneromimus* Gahan. With these, there are now four Malayan genera comprising six species, all of which are obviously closely related one to another and to *Tenerus*. The first of these, *Anisophyllus* Westw., is distinguished by having each of the intermediate antennal segments furnished with a conspicuous ramus. Through the extreme kindness of Prof. E. B. Poulton, who has given me certain information concerning Westwood's type, it is possible to rectify Gorham's error in transferring this genus to the Tillinæ and to restore it to the group in which it belongs and to which it was originally referred. However, it now becomes impossible to separate *Myopocera* Schklg. from it, and that genus must be suppressed. The second of the four genera, *Teneromimus* Gahan, is not as yet known from the Philippine Islands but may be found at some future time. It is represented by two species, *T. vitticollis* Gahan, its type, from Australia, and *T. humeralis* Gahan from the Solomon Islands. This genus is characterized as having ten-segmented antennæ, appendiculate tarsal claws, a reduced gular sclerite, and the lateral cariniform margin of the thorax feeble anteriorly. The above key to the genera recognized here emphasizes the differences between *Teneromimus* and the two new genera.

Though apparently of no great specific value, I would call attention to the tiny combs which occur at the apices of both anterior and middle tibiæ in the genera *Tenerus* and *Teneroides*. I have used the term pecten to designate these. In certain species, the number of denticles varies on the two sides of the same insect and for that reason I have not attempted to make use of that character.

Genus **ALLOCHOTES** Westwood

Allochotes WESTWOOD, Trans. Ent. Soc. London (1875) 241; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 98; GAHAN, Ann. & Mag. Nat. Hist. VIII 5 (1910) 69. (Genotype: *bicolor* Westw., New Guinea.)

Sisyrnophorus WATERHOUSE, Ent. Mo. Mag. 13 (1876) 125. (Genotype: *maculatus* Waterh., Philippine Islands.)

Generic characters.—Enopliinæ; form hemispherical, subretractile, closely resembling insects of the family Coccinellidæ; antennæ eleven-segmented, first segment stout and slightly bent, second short and globular, from the third on each segment is

slightly broader than the last, terminal segment about as long as ninth and tenth taken together; eyes rather flat, conspicuously and deeply emarginate at base of antennæ; terminal segments of both sets of palpi elongate-triangular. Thorax as seen from above with a semicircular outline, the sides and base forming an even curve from one anterior angle to the other, anterior coxal cavities very broadly open behind, prosternum remarkably short. Elytra with punctures evenly distributed over surface but not in definite rows, lateral margins explanate. Abdominal segments short and broad, fifth and sixth with slight secondary sex modifications. Legs short, femora not swollen in either sex, tarsi moderately long and stout, lobes large and prominent, claws with broad basal tooth.

Geographic distribution, Indo-Malaysia.

About sixteen species of this genus are known, three of which occur in the Philippine Islands. One of these is the monobasic type of *Sisyrnophorus* Waterh., which genus is at present not considered as distinct from *Allochotes* Westw.

The following key is based partly on word description (*maculatus* Waterhouse) and partly on material before me:

Key to Philippine species of Allochotes Westwood.

1. Elytra each with four circular spots; thorax with three spots. **A. maculatus** (Waterhouse).
   Elytra and thorax immaculate .... 2.
2. Last abdominal tergite of male rounded, fifth sternite emarginate, sixth sternite rounded .... **A. bakeri** sp. nov.
   Last abdominal tergite of male truncate, fifth and sixth sternites rounded. **A. pallidus** sp. nov.

Allochotes maculatus (Waterhouse).

Sisyrnophorus maculatus WATERHOUSE, Ent. Mo. Mag. **13** (1876) 126.

Testaceo-ferrugineus, convexus, nitidus, pubescens; thorace maculis tribus, scutello, elytrisque maculis rotundatis octo, nigris. Long. 4 lin., lat. 3⅓ lin.

Head sub-rotundate, not very convex, with fine punctures not thickly scattered over the surface; eyes moderately large, but not prominent; antennae with the 5th joint scarcely as broad as long, the 6th to 10th joints very gradually a little shorter and stouter. Thorax distinctly broader than the head, very convex, finely and moderately thickly punctured, one fifth broader than long, very gently narrowed in front, entirely rounded behind, finely margined, the anterior angles a little less than right angles; a discoidal spot and a smaller spot on each side black. Elytra twice as broad as the thorax, about as long as broad, very convex and ample, broadest across the middle, gently rounded at the sides and apex; each

elytron arched and gently sinuous at the base, with four rather large round black spots, one humeral, one marginal, and two near the suture. Head and thorax sub-retractile.

Hab.: Philippine Islands. Brit. Mus.

As this species is unknown to me in nature, I have copied the original description. Nothing at all resembling the above description has been sent me.

Allochotes bakeri sp. nov. Plate 3, fig. 18.

Form ovate. Color testaceous except for the tips of the mandibles, which are black. Head pubescent, very finely and sparsely punctured; antennæ with segments 1 to 3 glabrous, 4 to 11 densely clothed with fine pubescence. Thorax much broader than the head, basal angles wanting, anterior angles slightly less than 90°, finely margined except on anterior edge where margin fails across the median portion; punctures very fine and sparse, becoming slightly denser toward the sides, pubescence moderately dense and long. Scutellum small, truncate behind. Elytra together nearly hemispherical, broadest just behind humeri, margin very fine and complete except along basal part of suture where it is wanting; punctuation moderately coarse and dense, evenly distributed. Underparts and legs finely and densely punctured. Length, 5 to 8 millimeters.

Male.—Fifth sternite slightly emarginate, sixth sternite rounded; terminal tergite truncate.

Female.—Unknown.

Type, a male, 8 millimeters, from Iligan, Lanao Province, Mindanao; paratype, a male, 5 millimeters, from Basilan. Both specimens collected by Baker.

Except for the great difference in size, I am unable to detect a single character that would serve to distinguish the specimens. On the other hand, there is no reason why the same species should not occur on both of these islands and, in fact, even in *Callimerus*, noted for its localized distribution, the same species occurs on both. It is probable that the two islands were connected with one another up to comparatively recent times.

Allochotes pallidus sp. nov.

Similar in appearance to the type of *A. bakeri* sp. nov. Differs in being more heavily punctured, especially on the abdominal segments, where the punctures are so close as to leave a dull surface, while in *A. bakeri* the corresponding portions of the insect are shining. The pubescence is conspicuously longer

in this species than in the last. Thorax is slightly less broad proportionally than in the last. Length, 8.7 millimeters.

Male.—Last abdominal tergite sharply truncate, fifth sternite slightly produced and broadly rounded, sixth sternite more sharply rounded.

Female.—Unknown.

Type, a male from Mount Maquiling, Laguna Province, Luzon (*Baker*).

Were it not for the quite different configuration of the ventral segments of the males, I should hesitate to describe both of the above species. The secondary sexual characters of the males, together with the distinct difference in the punctuation of the abdominal segments leave no doubt in my mind as to the propriety of separating the specimens under two names.

Genus **TENERUS** Castelnau

Tenerus CASTELNAU, Silberm. Rev. Ent. 4 (1836) 43; SPINOLA, Rev. Mag. Zool. (1841) 73; Monog. Clérites 1 (1844) 161; LACORDAIRE, Gen. Col. 4 (1857) 475; GORHAM, Trans. Ent. Soc. London (1877) 402; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 99; HINTZ, Deutsche Ent. Zeit. (1905) 312; SCHENKLING, Col. Cat. (Junk) Cleridae (1910) 117.

Generic characters.—Enopliinæ; head short and broad, labrum variable, terminal segment of maxillary palp slender, parallel, apex obliquely truncate, that of labial palp similar but smaller; antennæ eleven-segmented, first segment stout, bent, second nearly spherical, third twice as long as broad, rarely perceptibly dilated at apex, fourth to tenth subequal, triangular, as broad as long, eleventh twice as long as broad, diamond-shaped or oval. Thorax quadrate or nearly so, lateral cariniform margin distinct, sides subparallel. Anterior coxal cavities broadly open behind. Scutellum distinct, elytra long, parallel, never punctured in rows. Abdomen with six visible sternites, fifth and sixth sternites of male modified, fifth sternite of female with small notch, as in *Teneroides* Gahan. Legs short and stout, tarsi short, fourth segment very small, claws with a broad basal tooth.

Genotype, *Tenerus praeustus* Cast.

A genus of nearly ninety known species, three-quarters of which occur in the Indo-Australian region, the rest being African. To the four species previously known from the Philippine Islands I am able to add ten.

Key to Philippine species of Tenerus Castelnau.

1. Elytra at least in part blue or with bluish iridescence .... 2.
   Elytra not in any part blue .... 7.
2. Elytra entirely blue above the marginal bead .... 3.
   Elytra partly reddish above the marginal bead .... 6.
3. Size very large (13 millimeters), antennæ entirely pale, head mostly dark above .... **T. magnus** sp. nov.
   Size smaller (not over 9 millimeters), antennæ entirely or almost entirely black .... 4.
4. Head black, pronotum reddish with anterior margin and a small spot at the base black, abdomen reddish .... **T. cyanopterus** Spinola.
   Head and pronotum entirely reddish testaceous .... 5.
5. Antennæ and abdomen entirely dark, anterior angles of pronotum deeply and moderately densely punctate .... **T. luzonicus** sp. nov.
   Antennæ with first segment pale, abdomen concolorous with the thorax, anterior angles of pronotum rather sparsely and finely punctured. **T. sibuyanus** sp. nov.
6. Elytra reddish with the apices broadly blue, antennæ black. **T. philippinarum** Chevrolat.
   Elytra bluish except for the extreme apices and anteapical spot near suture which are red, antennæ entirely pale yellow. **T. pulcher** sp. nov.
7. Elytra entirely black .... 8.
   Elytra not entirely black .... 9.
8. Elytra each with a single pronounced costa near the suture, abdomen mostly pale, anterior margin of thorax broadly black. **T. mindanaonicus** Gorham.
   Elytra without costæ, abdomen black, anterior margin of thorax with three small black spots .... **T. trinotatus** sp. nov.
9. Elytra black, each with a rather broad longitudinal subsutural vitta of pale testaceous .... **T. vittiger** sp. nov.
   Elytra brown with black tips .... 10.
10. Elytra without a costa near the suture, head black, thorax entirely pale. **T. acostatus** sp. nov.
    Elytra with a very distinct costa near suture .... 11.
11. Pronotum with two round black spots on the anterior margin, costa not reaching to the middle of length of the elytron. **T. signaticollis** Castelnau.
    Pronotum not with two separate spots on the anterior margin, costa reaching to beyond the middle of length of the elytron .... 12.
12. Pronotum anteriorly black, head entirely black .... **T. nigripes** sp. nov.
    Pronotum and head entirely pale .... 13.
13. Abdomen and legs black, fifth abdominal sternite of female without notch at middle .... **T. obscurus** sp. nov.
    Abdomen and legs pale, fifth abdominal sternite of female notched at middle .... **T. basilanicus** sp. nov.

The above key is purely artificial. Naturally, the species fall into three groups according to the following:

1. Elytra minutely tuberculate or granulate.. Group A.
   Elytra punctate... 2.
2. Elytra each with a very distinct costa on the disk, anterior portion of pronotum granulate.. Group B.
   Elytra acostate, pronotum with simple punctures over the entire surface .... Group C.

GROUP A

Tenerus trinotatus sp. nov.

Form slender, parallel. Black, thorax and most of head and anterior and middle femora pale, pronotum with three black spots on anterior margin. Head with occipital dark spot rather small, very finely and sparsely punctured, sparsely pubescent. Thorax equilateral, slightly wider behind, basal margin discontinuous on either side of the disk, surface very finely and rather densely punctured, the punctures near the anterior margin replaced by granulation; the central spot triangular, the apex lying on the median line almost halfway to the basal margin, the lateral spots directly above the eyes, smaller and round. Scutellum pale, very slightly notched behind. Elytra with tips separately rounded, minutely and densely tuberculate instead of punctate, each tubercle giving rise to a hair. Costæ absent, suture and lateral margin beaded, bead continuous across base but absent across apex. Underparts finely punctured, sparsely pubescent. Length, 5 millimeters.

Male.—Unknown.

Female.—Fifth abdominal sternite with a deep, narrow slot.

Type, a female from Sibuyan, collected by Baker.

Distinguished immediately from all other known Philippine species by the granulations on the elytra in place of punctures.

GROUP B

Tenerus magnus sp. nov. Plate 3, fig. 20.

Size large for the genus, form cylindrical, body about as deep as broad. Head dark piceous except for a pale interocular spot extending forward to labrum, rather coarsely and densely punctured, punctures slightly denser on vertex and upper part of frons; pubescence rather sparse, black; antennæ reaching about to base of pronotum, segments of serrate portion slightly broader than long. Pronotum almost equilateral, anterior transverse impression feeble but distinct, surface anterior to the impression minutely tuberculate, rest of surface sparsely but

rather coarsely punctured; basal marginal bead broken slightly on either side of the middle; pubescence sparse, erect, fulvous. Scutellum brownish. Elytra long, sides straight and parallel, each with a single costa on disk, which becomes obsolete at basal third, punctures slightly coarser than those of pronotum but much more densely placed, lateral marginal bead entire across apex, joining sutural bead, pubescence mixed black and gray, the black hairs longer, sparser, and more erect. Underparts very finely and rather sparsely punctured. Legs moderate, middle tibia of female with eight denticles in pecten. Length, 13 millimeters.

Male.—Unknown.

Female.—Fifth abdominal sternite with a broad shallow emargination, sixth sternite simple, rounded; terminal tergite similar.

Type, a female from Butuan, Agusan Province, Mindanao (*Baker 17581*).

The largest of the Philippine species before me. Separated from all of the related species by the entirely pale antennæ.

Tenerus pulcher sp. nov.

Form depressed, parallel. Color as described in key and below. Head finely and rather densely punctured, pubescence short and dense, vertex with a rectangular black spot reaching from between the eyes to the occiput, spot two-thirds as wide as long, a small black spot beneath and behind each eye, mandibles and palpi dark, rest of head and appendages pale yellowish. Pronotum with sides slightly curved, broader than long, anterior transverse impression well back toward the middle of the length, shallow and poorly defined, surface anterior to impression black and minutely tuberculate, that posterior to impression, with the exception of a small black spot on the flank, reddish yellow and finely and densely punctured; pubescence rather dense, colored as the surface whence it arises; marginal bead broken sharply on base near posterior angles. Scutellum black. Elytra long, parallel, very densely and rather minutely punctured, discal costæ absent, apices rounded, without bead, pubescence mostly golden, a small posthumeral spot and a subapical transverse bar being black; each elytron dark blue, with the extreme apex and extreme lateral margin from just behind the base to apical third, which is reddish yellow; a semicircular spot at apical fourth lying close to the sutural bead of the same color. Underparts pale, finely and densely punctured, densely pubescent.

Legs pale except for the tibial extremities of the anterior femora, anterior tibiæ, and all tarsi, which are black. Length, 6 to 7.5 millimeters.

Male.—Fifth abdominal sternite broadly and shallowly emarginate with an oval median depression; sixth sternite retracted, invisible in specimen; terminal tergite broadly rounded.

Female.—Fifth sternite with a narrow but very deep notch, the depth of the notch being almost one-half total length of segment; sixth sternite narrow, rounded at apex; terminal tergite feebly emarginate with a minute process in the center of the emargination.

Type, a male from Basilan; paratype, a female from the same locality; both specimens collected by Baker.

By far the most beautiful species of the genus known to me and closely allied to the next.

Tenerus mindanaonicus Gorham.

Tenerus mindanaonicus GORHAM, Trans. Ent. Soc. London (1877) 407.

Form cylindrical, rather stout. Reddish testaceous; head, anterior margin of thorax, elytra, tibiæ, tarsi, and last three abdominal sternites dark. Head rather coarsely and not densely punctured, pubescence sparse, front below the supraantennal ridges paler than vertex. Thorax about equilateral, anterior transverse impression distinct, surface anterior to impression minutely tuberculate, the rest rather coarsely and at the sides rather densely punctured, pubescence sparse. Lateral marginal bead carried across base of pronotum unbroken. Scutellum black. Elytra black, more densely and coarsely punctured than the pronotum, each with a single well-defined costa on disk, pubescence of black and gray hairs mixed, the black hairs sparse and erect, the gray denser and depressed. Marginal bead continued across the apex to join sutural bead. Underparts finely and moderately densely punctured, very sparsely pubescent. Legs short, tibiæ and tarsi densely pubescent; tarsal claws paler than rest of segment. Length, 7.5 to 8 millimeters.

Male.—Unknown.

Female.—Fifth abdominal sternite with a V-shaped notch, only slightly deeper than wide; sixth sternite small, acutely rounded at tip; terminal tergite similar to sixth sternite.

Described as from "Mindanao." Two specimens from Surigao, Mindanao, both females, have been received from Baker. One specimen bears the number 17583.

Superficially somewhat resembling *T. trinotatus*, from which it is easily distinguished by the punctulate elytra and the presence of costa. It is, however, much more closely related structurally to the preceding species and to *T. nigripes*.

Tenerus nigripes sp. nov.

Form and size of *T. mindanaonicus* Gorham. Head finely and sparsely punctured, supraantennal ridges broad and low, pubescence fine but rather sparse; antennæ reaching well beyond base of pronotum. Pronotum equilateral, anterior transverse impression broad but rather deep, portion anterior to impression minutely tuberculate or granulate, black except at flanks, rest of pronotum moderately coarsely but sparsely punctured and reddish yellow; marginal bead sharply broken on either side of base. Elytra very slightly wider posteriorly, each with a discal costa extending from the base nearly to the dark color at apex, punctures about the same size as those on pronotum, very densely placed, becoming finer and indistinct at apex; color testaceous, the apical fourth black; marginal bead complete across apex, meeting the sutural bead. Underparts very finely and very sparsely punctured, the punctures of the last three visible sternites more distinct and densely placed. Legs moderate, femora rather broad and shining, tibiæ closely punctured and thickly clothed with pubescence. Underside of thorax and first three sternites pale, rest black. Length, 6.5 millimeters.

Male.—Unknown.

Female.—Fifth abdominal sternite with a narrow V-shaped notch, twice as deep as width at widest part; sixth sternite and terminal tergite triangular, rounded at tips.

Type, a female from Basilan (*Baker*).

Closely related to *T. mindanaonicus*, but distinct in the formation of the fifth sternite of the female.

Tenerus vittiger sp. nov.

Form parallel, convex above, elongate. Color black, thorax (except for basal, apical, and lateral spots which are black) reddish testaceous, elytra each with a rather broad longitudinal subsutural vitta, inclosing a pronounced costa, yellowish testaceous. Head densely and finely punctured, sparsely pubescent. Thorax nearly square, basal margin double, angles blunt; anterior transverse impression broad and shallow, curved with the convexity directed posteriorly; the anterior black spot is

irregular in shape, entirely anterior to the anterior impression, the posterior spot is nearly circular with lateral projections along the basal margin; the lateral spots are very small and lie close to the lateral margin; surface finely and densely punctured. Elytra long, parallel, margins fine and complete, punctures very fine and very densely placed; pale vitta reaching to apical fourth. Underparts finely punctured, abdomen black except for the pale first sternite. Hind trochanters pale, rest of legs black. Length, 5.5 millimeters.

Male.—Third abdominal sternite with a small roughened spot on either side of the median line; fourth with short oblique carinæ similarly placed, the carinæ convergent posteriorly; fifth with similar but more developed carinæ, in this case reaching the posterior margin of the sternite. The inclosed area on the fifth sternite is very rough.

Female.—Fifth abdominal sternite with a deep narrowed slot in the posterior margin.

Type, a male from Dapitan, Zamboanga Province, Mindanao; paratype, a female from Kolambugan, Lanao Province, Mindanao (*Baker 13513*).

Tenerus obscurus sp. nov.

Slenderer than *T. mindanaonicus* Gorham. Head finely and sparsely punctured, punctures near supraantennal ridges coarser and more closely placed. Color light piceous, antennæ black, reaching slightly beyond base of pronotum. Pronotum longer than broad, anterior transverse impression feeble and very indistinct, sides straight, parallel, marginal bead continuous across base, punctures on disk fine, on flanks coarser, moderately densely distributed, portion anterior to impression very finely and sparsely tuberculate, color reddish testaceous. Scutellum pale. Elytra each with a discal costa reaching from the base to about apical third, finely and rather densely punctured, the punctures becoming very fine at apices and almost indistinguishable, pubescence dense, fulvous; basal half pale reddish brown, apical half fuscous black, the line of demarcation between the colors indefinite. Metasternum and first abdominal sternite very sparsely punctured, other parts of thorax and abdomen densely punctured, the punctures fine on the thorax and coarser on the abdomen, pro- and mesosterna and all coxæ pale, other parts dark piceous. Legs short and stout. Length, 5.5 millimeters.

Male.—Unknown.

Female.—Fifth sternite entire, without trace of the usual notch. The extreme tip of the abdomen is so retracted in the type and only specimen available as to make it impossible to state with assurance the exact contour. The sixth sternite appears to be entire and to have a longitudinal median carina extending from the apical margin toward the base.

Type, a female from Kolambugan, Lanao Province, Mindanao (*Baker*).

Tenerus basilanicus sp. nov.

Form moderately slender, parallel. Head entirely pale brownish yellow, finely and densely punctured, especially so near the supraantennal ridges; antennæ black, reaching well beyond the base of the pronotum. Pronotum pale brownish yellow, finely and densely punctured, sides straight and parallel, anterior transverse impression feeble, almost obsolete, anterior portion of pronotum minutely tuberculate. Pubescence of head and pronotum sparse, inconspicuous. Marginal bead broken at sides of base, very feebly developed across base. Scutellum pale. Elytra each with a discal costa reaching just beyond the middle, marginal bead continuous across apices, punctures rather fine and densely placed, toward the apices becoming much finer, almost obsolete; color brownish yellow, apical third of elytra black; pubescence sparse, suberect. Underparts brownish, the terminal segments of the abdomen slightly infuscate, first sternite sparsely, rest of abdomen densely punctured. Legs short, pecten of middle tibiæ with about four denticles, tarsi black. Length, 5.5 millimeters.

Male.—Unknown.

Female.—Fifth abdominal sternite with a very small median triangular notch; sixth sternite rounded, its apex slightly rolled outward; terminal tergite evenly rounded.

Type, a female from Basilan (*Baker*).

Nearest to *T. obscurus,* but easily separated from that species by the much closer punctuation of the head.

Tenerus signaticollis Castelnau.

Tenerus signaticollis CASTELNAU, Silberm. Rev. Ent. 4 (1836) 44.

This species was originally described from Java as follows:

Rouge, pubescent, finement ponctué. Corselet avec deux points noirs en avant. Elytres d'un brun jaune avec l'extrémité noire. Antennes, extrémité des cuisses jambes et tarses de cette dernière couleur.

In the case of the Philippine material, there is one point of difference that may prove constant in a series of specimens; namely, that the tibiæ are uniformly pale, only the tarsi being dark brown or black. The specific value of this character can only be demonstrated by the examination of series of specimens both from Java and from the Philippines. The material before me can be described as follows:

Form rather robust, parallel. Head entirely pale, rather coarsely and densely punctured, sparsely pubescent; antennæ entirely black, reaching slightly beyond the base of the pronotum, the intermediate segments acutely triangular. Pronotum with sides curved, slightly narrower anteriorly, anterior transverse impression feeble but apparent, portion anterior to impression minutely tuberculate, rest of surface coarsely punctured, the punctures much more densely placed on the flanks than on the disk; color brownish yellow, with two longitudinally oval spots, symmetrically placed, mainly on the tuberculate portion; marginal bead obsolete across base. Scutellum pale. Elytra each with a discal costa, rather feeble in the male, pronounced in the female, reaching from the base to about the middle of the length, marginal bead entire across the apices, meeting the sutural bead; punctures at base of elytra about as coarse as those of pronotum but much more densely placed; toward the apices the punctures become very fine; pubescence sparse, inconspicuous; color brownish yellow, the apical fifth of each elytron black. Underparts finely and sparsely punctured, sparsely pubescent. Legs moderate, pale, tarsi darker. Pecten of anterior and middle tibiæ with about four denticles in each. Length, 8 to 9.5 millimeters.

Male.—Fifth abdominal sternite with a broad, deep, semicircular depression inclosing a shallow emargination on the posterior margin of the sclerite; sixth sternite small, subtruncate; terminal tergite evenly rounded, its lateral margins tumid.

Female.—Fifth sternite with a V-shaped notch in posterior margin, the notch narrowing to its base; sixth sternite and terminal dorsal small, broadly and feebly emarginate.

Described from one male from Kolambugan, Lanao Province, Mindanao, and two females from Davao, Davao Province (*Baker 11555*) and Dapitan, Zamboanga Province, Mindanao (*Baker 12735*).

This species forms a sort of connecting link between the group of species designated in this paper as "B" and a group,

representatives of which I have from Borneo, in which the elytral costæ are absent but with the granulations present on the anterior portion of the pronotum.

GROUP C

Tenerus luzonicus sp. nov.

Size small, form slender, cylindrical. Head convex, without spot on vertex, sparsely and finely punctured, pubescence sparse and erect; antennæ with the first four segments shining, the fourth slightly shorter than the third and a little wider but not more than half as wide as the fifth. Thorax slightly longer than wide, sides parallel, anterior transverse impression obsolete, entire surface of pronotum sparsely but rather coarsely punctured, the punctures denser on the flanks, pubescence sparse, suberect. Scutellum reddish. Elytra with sides straight and parallel, without trace of costæ on disk, punctures very variable in size, small and large intermingled, limits of each puncture poorly defined; marginal bead obsolete at the internal apical angle; pubescence cinereous, of mixed erect and depressed hairs. Underparts finely but rather sparsely punctured, pubescence sparse, thorax and appendages pale, abdomen black. Legs moderate in length, femora of female a little stouter than usual in the genus. Length, 4.5 millimeters.

Male.—Unknown.

Female.—Fifth abdominal sternite with triangular notch, as wide as deep; sixth with a longitudinal median depression on basal half; terminal dorsal very feebly emarginate.

Type, a female from Mount Limay, Bataan Province, Luzon (*Baker*).

The smallest species seen by me from the Philippines, although, as there are two species from Borneo which are smaller, it is by no means the smallest in the genus.

Tenerus sibuyanus sp. nov.

Form rather broad for the genus, parallel. Antennæ, except for first segment, and extreme tip of abdomen dark, elytra blue, rest of body reddish yellow. Head finely and sparsely punctured, sparsely pubescent, spot on vertex usually found in the genus absent; antennæ reaching to beyond base of pronotum. Pronotum rather evenly, finely, and sparsely punctured, the median longitudinal line smooth, without punctures, lateral marginal bead broken on either side of the middle of base and rather indistinct across base, width across anterior margin dis-

tinctly less than that across base, sides straight, greatest width about equal to length. Scutellum pale. Elytra very finely and densely punctured, at the apices the punctures are obsolete and the surface shining, discal costæ absent, marginal bead complete across apices, meeting the sutural bead, pubescence black, very fine and inconspicuous. Underparts finely and sparsely punctured. Legs rather slender, pecten of anterior tibia with four, of middle tibia with three denticles. Length, 8 to 10 millimeters.

Male.—Fifth abdominal sternite with a broad, shallow arcuate emargination; sixth sternite and terminal tergite rounded, entire.

Female.—Fifth sternite with a V-shaped notch which is deeper than wide; sixth sternite smooth and shining except at apex, with a median longitudinal groove reaching almost to the acutely pointed apex; terminal tergite strongly tapered, subtruncate at tip.

Type, a male from Sibuyan; paratypes, three females from the same locality; all specimens collected by Baker.

Tenerus acostatus sp. nov.

Form cylindrical, slightly tapering at the posterior extremity. Pale yellow-brown, except for the head, antennæ, tibiæ, tarsi, and the extreme tips of the elytra, which are black. Head distinctly but sparsely punctured, sparsely pubescent; the median vertical line between the eyes is slightly paler than the rest of the head; labrum entire; antennæ comparatively short, hardly exceeding the base of the thorax. Thorax equilateral, sides parallel; anterior marginal bead fine, entire; posterior marginal bead widely broken near posterior angles; anterior transverse impression absent; surface sparsely punctured, the discal and anterior punctures very fine, those near the posterior angles coarser, pubescence sparse. Elytra without costæ, finely margined, the marginal bead entire across the apices, punctures very densely placed, slightly coarser than the coarse punctures of the thorax, pubescence sparse and inconspicuous. First abdominal sternite very sparsely punctured, underparts of the thorax more densely punctured and rest of abdomen very densely punctured. Femora sparsely, tibiæ densely punctured, pubescence moderate. Length, 9 millimeters.

Male.—Unknown.

Female.—Fifth abdominal sternite with a small median, acutely triangular notch; sixth sternite with a longitudinal

median depression; terminal dorsal broadly and shallowly emarginate.

Type, a female from Sibuyan (*Baker 18979*).

As close to *T. praeustus* Castelnau as any Philippine species studied. Differs in the dark head, tibiæ, and tarsi, and in the unicolorous abdomen.

POSITION UNCERTAIN

Tenerus philippinarum Chevrolat.

Tenerus philippinarum CHEVROLAT, Memoire Clérites (1876) 37.

Reddish; pubescence fulvous, short and dense; coriaceous. Head round and convex, densely and finely punctured, antennæ and eyes black. Prothorax quadrate, convex, punctulate; anteriorly truncate, posteriorly somewhat arcuate with a narrow marginal groove; scutellum triangular. Elytra with the tips broadly blue. Body beneath, femora, and tibiæ red, the last two abdominal sternites and the underside of the tarsi darker. Length, 9 millimeters; width, 4.5.

Type locality, Philippine Islands.

The above is a translation of the original description. I have seen no insect that compares at all well with the description but believe that when the species is again collected it will be readily recognized. However, there is some doubt in my mind as to the correctness of the generic assignment. At the time and place of original description, Chevrolat notes that *Tenerus* Castelnau and *Stenocylidrus* Spinola appear to him to be synonymous. From that one is able to deduce a lack of knowledge on his part of one or the other or both of the genera. The dimensions given above indicate an insect half as wide as long, a condition which I consider improbable, if not impossible, in the genus *Tenerus*. Until the type is reëxamined or until further material comes to light, the final disposition of the species is open.

Tenerus cyanopterus Spinola.

Tenerus cyanopterus SPINOLA, Monog. Clérites 1 (1844) 165, pl. 8, fig. 4.

As I have seen no material that can be identified as this species, the following description is derived from the original, cited above:

Form cylindrical, color reddish; head, a large transverse spot on the anterior margin, a smaller one on the posterior margin of the pronotum, the tibial extremities of the femora, the external portion of the tibiæ and the tarsi, black; antennæ black except for the first segment which is reddish. Punctuation of

the head sparse and indistinct, that of the elytra coarser and denser, slightly regular. Pubescence fine and sparse, cinereous. Length, 4 lines (about 8 millimeters).

Type, a specimen, sex not given, from Manille [Manila], Luzon.

On first glance, the species described in this paper under the name *T. luzonicus* was thought to be the same as that referred to above. The entirely dark abdomen of *luzonicus* shows, however, that full coloration has probably been obtained and that the absence of dark on the head and thorax is of specific value. It does not seem possible that either is the incompletely colored form of the other.

Genus TENEROIDES Gahan

Teneroides GAHAN, Ann. & Mag. Nat. Hist. VIII 5 (1910) 69.

This name was proposed by Gahan for a subgenus of *Tenerus* Cast., to include those species in which the antennæ are serrate from the third segment on. As this character appears always to be associated with others of equal or greater taxonomic value, the subgenus is here raised to generic rank.

Generic characters.—Enopliinæ; form elongate-cylindrical; antennæ eleven-segmented, segments from 3 on either broadly triangular or with short terminal rami; eyes finely granulate, deeply and broadly emarginate, terminal segment of maxillary palp elongate, cultriform, truncate at tip, terminal segment of labial palp similar in shape but smaller. Scutellum trapezoidal. Elytra long, suture closed the entire length, with or without well-developed costæ. Abdomen with six visible sternites, in the male the first, or second or third, or second and third, and fifth with conspicuous modification, the female with the fifth only modified but usually with the terminal tergite notched. Legs short and stout, hind trochanters of the males with spiniform or wedge-shaped process, hind femora of males swollen, tarsal claws with a broad basal tooth.

Genotype, *Teneroides tavoyanus* Gahan.

The four species of this genus that are known to me from the Philippines can be separated by the following key:

Key to Philippine species of Teneroides Gahan.

1. Elytra intensely black, thorax reddish yellow; process on first sternite of male very short and blunt, oval rather than triangular.
T. melanopterus sp. nov.

Elytra not black... 2.

2. Upper surface yellow-brown, sutural margin of elytra and lateral margins of thorax sometimes infuscate .... 3.
   Upper surface reddish vermilion, lateral margins of thorax blackish brown, female with a broad V-shaped notch on fifth sternite.
   T. aurantiacus sp. nov.
3. Thorax without a distinct tubercle before the scutellum, with a tubercle on either side of the gular sclerite .... **T. tuberculatus** sp. nov.
   Thorax with a distinct tubercle before the scutellum, tubercles at sides of gular sclerite absent .... **T. bakeri** sp. nov.

Teneroides melanopterus sp. nov. Plate 2, fig. 16.

Form cylindrical, sides parallel, thorax narrowed in front and behind. Black; thorax, part of head, and the lateral margins of elytra narrowly reddish yellow. Head very finely and densely punctured, pubescence fine, short, and black, reddish yellow except for black spot between and above the eyes and the black clypeal region; antennæ more than twice as long as head and thorax together, entirely black, segments 3 to 10 broader than long, the eleventh elongate oval. Thorax punctured similarly to head, pubescence fine, short, and reddish; greatest width at basal third, basal marginal bead double, anterior margin with single, inconspicuous rim. Scutellum reddish, cordate. Elytra long, parallel, individually rounded at tips, sutural bead distinct to tips, without costæ, punctuation very fine and very close, with a few large punctures scattered over the surface, pubescence fine and dense with a few coarse erect hairs. Underparts and legs finely punctured, not densely pubescent. Length, 8 to 10 millimeters.

Male.—First abdominal sternite with small median triangular tooth; posterior trochanters broadly wedge-shaped internally; posterior femora greatly swollen; fifth and sixth sternites depressed medianly; terminal tergite truncate with very feebly developed median lobe.

Female.—Posterior femora and trochanters normal; fifth sternite with small median notch; sixth sternite and terminal tergite unmodified, rounded.

Type, a male from Sibuyan (*Baker 18980*); paratype, a female with the same data.

Teneroides aurantiacus sp. nov.

Form elongate, parallel. Color vermilion, lateral margins of thorax, antennæ, legs, and hind body black. Head very finely and densely punctured, sparsely pubescent, occiput clouded with fuscous. Thorax quadrate, slightly wider behind, finely mar-

gined, lateral margins entire, punctuation very fine and dense, hind angles wrinkled, pubescence fine and moderately dense. Elytra long, very slightly wider posteriorly, surface finely and not densely punctured, the punctures appearing black, surface between the punctures finely alutaceous; pubescence on basal half sparse, on apical half denser and arranged in four longitudinal stripes; elytra not costate. Underparts finely and sparsely punctured, black with a bluish reflection, punctuation of legs coarser; basal half of anterior femora pale. Length, 7 millimeters.

Male.—Unknown.

Female.—With the usual notches in the margins of the fifth sternite and terminal tergite.

Type, a female from Iligan, Lanao Province, Mindanao (*Baker*); paratype, a female from Basilan (*Baker*).

At first glance the Basilan specimen appears different, owing to its slightly deeper color. However, there appear to be no other differences.

Teneroides tuberculatus sp. nov.

Head finely and rather densely punctured, a smooth median line from level of top of eyes to occiput, pubescence fine, of short fulvous hairs with a few longer black hairs intermingled, occipital blotch reaching forward almost to level of ocular emargination; antennæ, region above mouth, and occipital blotch black. Thorax slightly wider than long, widest at basal third, finely and densely punctured, densely pubescent; toward the anterior angles there are four or five larger punctures, which may possibly carry sensory setæ, anterior angles dark. Elytra long, lateral margins slightly sinuous, sutural bead rather broader than in the next species, apices together rounded, punctures of two sizes, the larger rather sparsely, the smaller very densely placed, pubescence dense, fine, yellowish brown; four costæ very faintly suggested. Underparts black with faint bluish reflections, anterior coxæ and all trochanters pale, punctures very fine and dense, posterior smooth, margins of sternites broad, very finely alutaceous, pubescence black, mostly short hairs with a few longer ones intermingled. Length, 11 millimeters.

Male.—Unknown.

Female.—With the usual notch in the terminal tergite and in posterior margin of fifth sternite.

Type, a female from Butuan, Agusan Province, Mindanao (*Baker 17582*).

Easily distinguished from the next species by the total absence of stripes of pubescence on the elytra.

Teneroides bakeri sp. nov.

Form elongate, parallel. Color as described in key, female with sutural region dark, antennæ, occipital blotch, metasternum, abdomen, and legs blackish. Head very finely and not densely punctured, median smooth line broken on vertex, pubescence black, short and erect; terminal segments of all palpi dark. Thorax broader than long, broadest just before the base, surface densely and very finely punctured, pubescence dense and depressed, concolorous with the thorax. Elytra long, lateral margins slightly sinuate, very feebly costate, punctuation as in the preceding species, pubescence dense and depressed. There appear to be nine or ten longitudinal stripes of pubescence, the hairs of the alternate stripes commencing with the suture directed posteriorly; the hairs of the other rows point forward. Hence, when the insect is held with the head toward the observer, the effect is of alternate light and dark stripes. Underparts finely and densely punctured, densely pubescent. Length, 9 to 11 millimeters.

Male.—Antennal segments 4 to 10 each with a broad process as long as the body of the segment; first abdominal sternite with a median acutely triangular projection, about one-fifth as long as the sternite, arising just in front of the posterior border; fifth sternite depressed in middle, broadly and shallowly emarginate; sixth sternite with a deep, median longitudinal groove; margin of the terminal tergite strongly thickened; hind trochanters produced internally into a semicircular plate.

Female.—Fifth sternite with a V-shaped notch. Terminal tergite with small notch.

Type, a male from Sibuyan (*Baker 18981*); paratype, a female from the same locality (*Baker 19338*).

Genus **PARATENERUS** novum

Generic characters.—Enopliinæ; head broad; labrum small, deeply emarginate, almost bilobed; eyes moderately finely granulated, deeply emarginated near insertion of antennæ; terminal segment of maxillary palp cylindrical, obliquely truncate at apex, that of labial palp cylindro-acuminate; antennæ eleven-segmented, first segment stout, two-thirds as thick as long, second globular, third to eighth short, closely fitted, forming a

mass about as long as the first and second segments together, ninth to eleventh very long, ninth and tenth each with ramus. Thorax quadrate or nearly so, lateral margin entire, anterior coxal cavities widely open behind. Elytra long, sides nearly parallel, almost covering abdomen, sometimes with faint costæ. Abdomen with six visible sternites, legs short and thick, claws with broad basal tooth.

Genotype, *Paratenerus mindanensis* sp. nov.

One species belonging to this interesting genus has been sent me by Professor Baker. The lateral margin of the thorax is complete and of even elevation throughout, and the antennæ are very distinctly eleven-segmented.

Paratenerus mindanensis sp. nov. Plate 3, fig. 21.

Form elongate-cylindrical. Color brown, covered with fulvous hairs, head and underparts darker. Head short, frons broad, finely and densely punctured; antennæ long, reaching to the middle of the length of the elytra, first eight segments together as long as ninth, tenth longer than ninth, eleventh the longest, more than twice the length of the ninth; ninth and tenth segments with short terminal rami. Thorax nearly quadrate, very finely and densely punctured, basal margin fine, distinct, pubescence fine and sparse, directed toward the median line. Scutellum moderate in size, round. Elytra long, not quite covering the abdomen, lateral margins sinuate just before the middle, surface finely roughened, individual punctures not distinct, densely covered with fulvous hairs. Underparts blackish, deeply and moderately densely punctured, lateral portions of abdominal sternites with small triangular smooth areas. Legs blackish, short, heavily punctured. Length, 5 millimeters.

Type, a specimen (sex uncertain) from Dapitan, Zamboanga Province, Mindanao (*Baker*).

The complete absence of secondary sexual modifications on any of the abdominal sternites suggests that the specimen is a female, but without dissection it is impossible to state so with certainty.

Genus **TENEROPSIS** novum

Generic characters.—Enopliinæ; head not very broad between the large, prominent, deeply emarginate, and moderately coarsely granulate eyes; labrum bilobed; terminal segments of both maxillary and labial palpi subcylindrical and slightly obliquely

truncate; antennæ ten-segmented, first segment stout and slightly bent, second slightly longer than broad, third to seventh of equal thickness, each shorter than the preceding, eighth and ninth broad, elongate-triangular, each as long as second to seventh, tenth elongate-cultriform. Thorax as long as greatest width, widest at basal third, tapering evenly anteriorly and posteriorly, lateral and basal margins entire, anterior coxal cavities moderately widely open behind. Elytra long, covering the abdomen, suture closed, distinctly broadest just behind the middle, punctuation confused, each elytron with very faint costæ. Abdomen with six visible ventral segments. Legs moderate, tarsi with five segments, the first partially concealed beneath the second, fourth very small, inserted between the lobes of the third, claws nearly simple.

Genotype, *Teneropsis sibuyanus* sp. nov.

This genus is probably much less closely related to *Tenerus* than the previous one. The gular region of the head is quite different and, while the antennæ are of the same number of segments as in *Teneromimus,* the funicular segments are comparatively long and distinct. Also, the tarsal claws are simple, a condition not commonly seen in this subfamily. The type species has somewhat the facies of an *Orthopleura.*

Teneropsis sibuyanus sp. nov. Plate 3, fig. 19.

Head with appendages, elytra, tibiæ, and tarsi almost black, thorax reddish brown, femora and underparts light piceous brown. Head coarsely and rather densely punctured, margin of eyes strongly beaded, supraantennal ridges prominent, surface sparsely pubescent with erect hair. Thorax finely and sparsely punctured, pubescence sparse, fulvous, anterior transverse impression broad and shallow, poorly defined. Scutellum black, transverse, feebly notched behind. Elytra together narrowly ovate, sutural margin beaded, lateral margins very slightly explanate, extreme basal margin and lateral margins to about basal third pale; punctuation in size of punctures similar to that of head, but more dense and confused; on the basal half there are a few single coarse punctures scattered among the fine ones; pubescence black, short, erect. Underparts finely but sparsely punctulate, except for the middle portion of the fifth sternite, which is very densely punctuate and pubescent; pubescence otherwise sparse. Length, 7.5 millimeters.

Male.—Fifth abdominal sternite with a small U-shaped notch at the middle of its posterior margin; sixth sternite and terminal tergite rounded.

Female.—Unknown.

Type, a male from Sibuyan (*Baker*).

KORYNETINÆ

Subfamily characters.—Cleridæ; eyes conspicuously though not always deeply emarginate; antennæ eleven-segmented, the three terminal segments forming a club. Lateral cariniform margin of prothorax distinct, at least toward the base, usually complete, anterior coxal cavities open behind. Elytra punctured in rows. Abdomen with the sixth sternite small, usually concealed by the fifth. Tarsi with five segments, the first sometimes small and partly concealed from above by the second, second and third large, fourth very small and indistinct, between the lobes of the third, fifth long. Claws simple or with basal tooth.

The genera that at present are assigned to this subfamily fall naturally into two groups, the first of these having a more or less oval form, the lateral cariniform margin of the pronotum complete, and the first tarsal segment moderately large. *Korynetes* Herbst, *Lebasiella* Spin., and *Necrobia* Oliv. are well-known examples of this type. The other group consists of such genera as *Tarsostenus* Spin., *Tarsostenodes* Blckb., and *Paratillus* Gorh., in which the form is very elongate-cylindrical, the lateral cariniform margin incomplete, and the first tarsal segment small and inconspicuous.

This subfamily is poorly represented in the Philippine fauna, only three species in two genera having been recorded from the Islands. The genera, one from each of the above-mentioned groups, are separable by the following characters:

Key to the Philippine genera of Korynetinæ.

Form elongate-cylindrical, first tarsal segment small, concealed from above by the second; lateral cariniform margin of prothorax evident only near the base; terminal segments of both palpi triangular; tarsal claws toothed at base .... **Tarsostenus** Spinola.

Form oval; first tarsal segment distinct; lateral cariniform margin of the prothorax complete; terminal segments of both maxillary and labial palpi cylindro-acuminate; tarsal claws simple .... **Necrobia** Olivier.

Genus TARSOSTENUS Spinola

Tarsostenus SPINOLA, Monog. Clérites 1 (1844) 287; LACORDAIRE, Gen. Col. 4 (1857) 452; JACQ. DU VAL, Gen. Col. d'Eur. 3 (1861) 198; BLACKBURN, Trans. Roy. Soc. South Australia 24 (1900) 138; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 58; Col. Cat. (Junk) Cleridae (1910) 138; GAHAN, Ann. & Mag. Nat. Hist. VIII 5 (1910) 59.

Generic characters.—Korynetinæ, with the first tarsal segment small; head moderate, eyes moderately coarsely granulate, triangularly emarginate; antennæ eleven-segmented, basal segment stout, second longer than wide, third to eighth of equal width, each shorter than the preceding, ninth and tenth triangular, about twice as wide as eighth and somewhat longer, eleventh oval, longer than tenth but of equal width; labrum deeply emarginate, almost bilobed; terminal segments of both maxillary and labial palpi similar, triangular, subequal. Thorax with feeble lateral cariniform margin, present in the basal half, anterior coxal cavities open behind. Elytra covering abdomen, suture closed, punctures, in rows, becoming obsolete on apical half. Abdomen with sixth segment small, usually visible. Legs moderate, tarsi with five segments, the first and fourth small, second and third with lobes beneath; claws simple, somewhat swollen at base.

Genotype, *Tarsostenus univittatus* Rossi.

The genus at present consists of the single species which occurs over practically the entire globe. It is the most important predaceous enemy of the species of *Lyctus* which burrow in manufactured hardwood. Where the species originated is not known.

Tarsostenus univittatus Rossi. Plate 2, fig. 15.

Tarsostenus univittatus ROSSI, Fauna Etr. 1 (1792) 44; KLUG, Clerii (1842) 321; SPINOLA, Monog. Clérites 1 (1844) 288; JACQ. DU VAL, Gen. Col. d'Eur. 3 (1861) 198; LEWIS, Ann. & Mag. Nat. Hist. VI 10 (1892) 188; HOULBERT and BETIS, Trav. scient. Univ. Rennes 4 (1905) 131, fig. 34.

Tarsostenus albofasciatus MELSH., Proc. Acad. Philad. 2 (1846) 306; LECONTE, Ann. Lyc. Nat. Hist. New York 5 (1852) 17.

Tarsostenus biguttatus MONTRZ., Ann. Soc. Ent. France III 8 (1860) 260; FAUV., Bull. Soc. Ent. France V 5 (1875) 88.

Tarsostenus fasciatellus SPINOLA, Monog. Clérites 2 (1844) 172, pl. 8, fig. 5.

Tarsostenus fasciatus CURTIS, Brit. Ent. 6 (1832) pl. 270.

Tarsostenus moerens WESTWOOD, in White, Cat. Col. Brit. Mus., Cleridae (1849) 57; Proc. Zool. Soc. London (1852) 50, pl. 26, fig. 10; BLACKBURN, Trans. Roy. Soc. South Australia 24 (1900) 136.

Tarsostenus picipennis WESTWOOD, in White, Cat. Col. Brit. Mus., Cléridae (1849) 48.
Tarsostenus succinctus CHEVROLAT, Rev. Mag. Zool. (1842) 277; LACORDAIRE, Gen. Col. 4 (1857) 452 (footnote).

Form elongate-cylindrical; head very coarsely and sparsely punctured, the punctures slightly crowded near the antennal insertions, piceous; antennæ and palpi pale brown, the club of the former dark. Pronotum longer than wide, sides parallel in the anterior two-thirds, base somewhat constricted, margined; punctures very large, adjacent on the flanks, scattered on the disk; anteriorly, a depressed median area, posteriorly two depressed areas, one on either side of the median line, these areas more densely punctured, color piceous. Pubescence on head and thorax sparse, erect. Elytra piceous with a postmedian transverse bar of white, interrupted at suture; punctures large, arranged in ten rows which become obsolete just beyond the white bar; apical portion with fine punctures, irregularly placed. Underside of thorax sparsely and coarsely punctured, abdomen sparsely but more finely so. Legs moderate, femora somewhat thickened, tibiæ and tarsi slender. Length, 4 to 5 millimeters.

Widely distributed wherever beetles of the genus *Lyctus* are found. Professor Baker has collected the species on Basilan, and at Los Baños, Laguna Province, Luzon (*Baker 14664*).

Genus **NECROBIA** Olivier

Necrobia OLIVIER, Ent. 4 (1795) 76 bis; KLUG, Clerii (1842) 349; SPINOLA, Monog. Clérites 2 (1844) 98; LACORDAIRE, Gen. Col. 4 (1857) 490; GORHAM, Trans. Ent. Soc. London (1878) 159; SCHENKLING, Gen. Ins. (Wytsman) Cleridae (1903) 119; Col. Cat. (Junk) Cleridae (1910) 141.
Agnonolia MULSANT, Col. France, Augusticolles (1863) 122.

Generic characters.—Korynetinæ, with the first tarsal segment large, lobed beneath. Head moderate, eyes moderately coarsely granulate, rather deeply and conspicuously emarginate, labrum emarginate; antennæ eleven-segmented, first segment stout, second about as broad as long, third to eighth subequal in breadth, each shorter than the one preceding, ninth to eleventh forming a compact capitate club, terminal segment of both palpi cylindro-acuminate. Prothorax broader than long, lateral cariniform margin complete and distinct, anterior coxal cavities narrowly open behind. Elytra covering the abdomen, with coarse and fine punctures, the former arranged in more or less distinct rows. Abdomen with the sixth sternite small, usually

concealed by the fifth. Legs moderate, tarsi with the fourth segment very small, claws broadly toothed at base.

Genotype, *Necrobia violacea* (Linnæus). Plate 3, fig. 27.

This genus contains about a dozen known species, of which three are more or less cosmopolitan. These insects infest drying or decaying animal matter, feeding on the larvæ of the true carrion insects. *Necrobia rufipes* DeG. is commonly met with in packing houses, about ham and bacon; *N. ruficollis* (Fabr.) appears to prefer partially dried bones; while *N. violacea* (Linn.) is attracted to carcasses of animals soon after their death. Since the last-mentioned species may be taken in the Philippines at a future date, I have included it in the following key with the two species already known from the Islands:

Key to species of Necrobia Olivier.

1. Upper surface bicolored, the thorax and base of the elytra red, rest of elytra and head metallic blue-green............ **N. ruficollis** (Fabricius).
   Upper surface entirely blue-green or blue.. 2.
2. Antennæ entirely black, legs bluish black............ **N. violacea** (Linnæus).
   Antennæ with the basal segments castaneous, legs entirely castaneous. **N. rufipes** de Geer.

Necrobia ruficollis (Fabricius).

Dermestes ruficollis FABRICIUS, Syst. Ent. (1775) 57; KLUG, Clerii (1842) 350; SPINOLA, Monog. Clérites 2 (1844) 103, pl. 43, fig. 6; CHENU, Encycl. d'Hist. Nat., Col. 2 (1860) fig. 198; HOULBERT and BETIS, Trans. scient. Univ. Rennes 4 (1905) 134, fig. 41.

Form oval, depressed. Head coarsely and densely punctured, supraantennal ridges sharply defined, frons and vertex blue, occiput reddish, epistoma testaceous, labrum piceous; antennæ reaching to the base of the pronotum, ninth segment conspicuously narrower than the tenth; pubescence sparse, erect. Pronotum broader than long, widest across middle of length, sides angulate, margins beaded, surface coarsely, on the disk sparsely, on the flanks densely and confluently punctured. Elytra with nine rows of punctures, surface between the puncture rows finely punctulate, pubescence sparse and erect; color blue with the basal fifth reddish, the red continued along the lateral margin for a short distance. Underparts finely and densely punctured, reddish, the abdomen slightly darker, pubescence sparse. Legs moderate, the tibiæ fringed on the outer margin with long pale hairs. Length, 5 millimeters.

Cosmopolitan or nearly so. Though I have not as yet seen specimens from the Philippine Islands, the species has been

reported as from there by Gorham (1878). It should occur in or about the larger cities and towns, rather than on the less-settled islands.

Necrobia rufipes de Geer. Plate 2, fig. 17.

Necrobia rufipes DE GEER, Mém. 5 (1775) 165, pl. 15, fig. 3; KLUG, Clerii (1842) 350; SPINOLA, Monog. Clérites 2 (1844) 101, pl. 42, fig. 6.

Necrobia amethystina STEPH., Ill. Brit. 5 (1832) 417; KLUG, Clerii (1842) 394.

Necrobia dermestoides PILL et MITTERB., It. Poseg. (1783) 68, pl. 7, fig. 8.

Necrobia foveicollis SCHENKLING, Mitteil. Mus. Hamburg 17 (1900) 20.

Necrobia glabra CHAMPOLLION, Mag. Encycl. Millin. 3 (1814) 41; SCHENKLING, Bull. Mus. Nat. Hist. Paris 8 (1902) 332.

Necrobia mumiarum HOPE, Hist. Egypt Mum. Pettigr. (1834) 54, pl. 5, figs. 1–3; SCHENKLING, Bull. Mus. Nat. Hist. Paris 8 (1902) 332.

Necrobia pilifera REITT., Verh. Nat. Vet. Brünn 32 (1894) (1893) 85; ABEILLE, Bull. Soc. Ent. France (1895) 208.

Form of *N. ruficollis*. Head very irregularly punctured, the punctures of two sizes, very coarse and very fine; antennæ with the basal segments reddish, the ninth as wide or nearly as wide as the tenth. Pronotum as in *ruficollis* but with the lateral margins more rounded, punctures coarse, sparse on disk, crowded at sides. Elytra with puncture rows very indistinct, surface between puncture rows densely and rather roughly punctured, from each puncture a hair arises which is directed backward instead of upward. Underparts moderately finely and densely punctured, sparsely pubescent. Legs moderate, tibiæ densely punctured, without conspicuous fringe of hairs. Length, 3.5 to 7 millimeters.

Cosmopolitan. This species varies considerably in size and color, the blue being frequently replaced by green. While I have seen but one Philippine specimen, from Tangkulan, Bukidnon Province, Mindanao, I am sure that the species must be widely distributed in the Islands.

BIBLIOGRAPHY

BARBOUR, THOMAS.

1911. The zoögeography of the East Indian Archipelago (translation of van Kampen 1909). Am. Nat. 45: 537–560.

1912. A contribution to the zoögeography of the East Indian Islands. Mem. Mus. Comp. Zool. Harvard 44: 5–203, pls. 1–8.

BAER, G. A.
1886. Catalogue des Coléoptères des Iles Philippines. Ann. Soc. Ent. France VI 6: 97–200.

BÖVING, A. G., and CHAMPLAIN, A. B.
1920. Larvae of North American beetles of the family Cleridae. Proc. U. S. Nat. Mus. 57: 575–649, pls. 42–53.
1922. The larva of the North American beetle Zenodosus sanguineus Say of the family Cleridæ. Proc. Ent. Soc. Wash. 24: 9–10, pl. 4.

CASEY, THOMAS L.
1897. Coleopterological notices, VII. Ann. New York Acad. Sci. 9: 285–684.

CASTELNAU, LAPORTE DE.
1836. Études entomologiques, ou descriptions d'insectes nouveaux et observations sur la synonymie. Silb. Rev. Ent. 4: 5–60.

CHAPIN, EDWARD A.
1919. New species of Coleoptera (fam. Cleridæ) from the Philippines and neighboring regions, collected by Prof. Charles F. Baker. Proc. Biol. Soc. Wash. 32: 225–234.
1922. New species of Callimerus from Mindanao, Philippine Islands. Proc. Biol. Soc. Wash. 35: 133–134.

CHENU, JEAN CHARLES.
1860. Encyclopédie d'histoire naturelle ou traite complet de cette science d'apres les travaux des naturalistes les plus eminents etc. Coleoptera 2: 1–312, pls. Paris.

CHEVROLAT, A.
1874. Catalogue des Clerides de la collection de M. A. Chevrolat. Rev. et Mag. Zool. III 2: 252–329.
1876. Mémoire sur la famille des Clérites 1–51. Paris.

FABRICIUS, J. C.
1775. Systema Entomologiae sistens Insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus observationibus 1–268. Flensburg et Lipsiae.

GAHAN, CHARLES J.
1910. Notes on Cleridae and descriptions of some new genera and species of this family of Coleoptera. Ann. & Mag. Nat. Hist. VIII 5: 55–76.

GORHAM, HENRY STEPHEN.
1876. Notes on the coleopterous family Cleridae, with descriptions of new genera and species. Cist. Ent. 2: 57–106.
1877. Descriptions of new species of Cleridae. Trans. Ent. Soc. London 245–263.
1877. Descriptions of new species of Cleridae, with notes on the genera and corrections of synonymy. Trans. Ent. Soc. London 401–426.
1878. Descriptions of new genera and species of Cleridae, with notes on the genera and corrections of synonymy. Trans. Ent. Soc. London 153–167.

1895. List of the Coleoptera in the collection of H. E. Andrewes Esq. from India and Burma, with descriptions of new species and notes. Families Malacodermata–Erotylidae–Endomychidae. Ann. Soc. Ent. Belg. **39**: 293–330.

GRAY, GEORGE.
1832. The Animal Kingdom arranged in conformity with its organization by the Baron Cuvier etc. by Edward Griffith **14**. Insecta **1**, notices of new genera and species by George Gray 1–570, pls. London.

HELLER, K. M.
1921. New Philippine Coleoptera. Philip. Journ. Sci. **19**: 523–637, pls. 1–3.

JONES, CHARLES R.
1913. The cigarette beetle (Lasioderma serricorne Fabr.) in the Philippine Islands. Philip. Journ. Sci. § D **8**: 1–42, pls. 1–9.

KLUG, J. C. F.
1842. Versuch einer systematischen Bestimmung und Auseinandersetzung der Gattungen und Arten der Clerii, eine Insectenfamilie aus der Ordnung der Coleopteren. From Abhandl. Berl. Akad.

KUWERT, A.
1894. Revision der Cleridengattung Omadius Lap. Ann. Soc. Ent. Belg. **38**: 62–97.
1894. Revision des Genus Stigmatium und der diesem Genus verwandten Gattungen nebst Bestimmungstabelle der mir zur Kenntniss gekommenen und bisher beschriebenen Arten. Ann. Soc. Ent. Belg. **38**: No. 8, 398–457.

LACORDAIRE, [JEAN] THÉODORE.
1857. Histoire naturelle des insectes. Genera des Coléoptères, ou exposé méthodique et critique de tous les genres proposés jusqu'ici dans cet ordre d'Insectes **4**. Paris.

LATREILLE, P. A.
1810. Considérations générales sur l'ordre naturel des animaux composant les classes des Crustacés, des Arachnides, et des Insectes; avec un tableau méthodique de leurs genres, disposés en familles. 1–444. Paris.

LEFEBVRE, A.
1835. Description d'un coléoptère nouveau du genre Clerus sous ses divers états. Ann. Soc. Ent. France I **4**: 575–585, pl. 16.
1838. Nouvelles diverses. Bull. Ent. Soc. France I **7**: 10–13.

LEWIS, G.
1892. On the Japanese Cleridae. Ann. & Mag. Nat. Hist. VI **10**: 183–192.
1895. On the Dascillidae and Malacoderm Coleoptera of Japan. Ann. & Mag. Nat. Hist. VI **16**: 98–122, pl. 6.

LOHDE, REINHARD.
1900. Cleridarum Catalogus. Stett. Ent. Zeit. **61**: 3–148.

McGregor, Richard C.
1920. Some features of the Philippine ornis with notes on the vegetation in relation to the avifauna. Philip. Journ. Sci. **16**: 361–437, pls. 1–35.

Olivier, O.
1790. Entomologie, ou Histoire naturelle des Insectes, etc. **1–6** Paris.

Runner, G. A.
1919. The tobacco beetle: an important pest in tobacco products. Bull. U. S. Dept. Agr. **737**: 77, pls. 4, figs. 16.

Schenkling, Sigmund.
1903. Zur Systematik der Cleriden. Deutsche Ent. Zeitsch. 9–16.
1903. Genera Insectorum. Coleoptera Malacodermata, Fam. Cleridae. Bruxelles.
1906. Die Cleriden des Deutschen Entomologischen National-Museums, nebst Beschreibungen neuer Arten. Deutsche Ent. Zeitsch. 241–320.
1910. Coleopterorum Catalogus auspiciis et auxilio W. Junk editus a S. Schenkling. Pars 23: S. Schenkling, Cleridae. Berlin.
1913. Zwei neue Philippinische Cleriden. Philip. Journ. Sci. § D **8**: 303–304.

Schultze, W.
1916. A catalogue of Philippine Coleoptera. Philip. Journ. Sci. § D **11**: 1–194.

Spinola, Maximilien.
1841. Monographie des Térédiles. Revue Zool. **4**: 70–76.
1844. Essai monographique sur les Clérites insectes coléoptères **1** and **2**, and one volume of plates. Geneva.

Thomson, James.
1860. Matériaux pour servir a une monographie nouvelle de la famille des Clérides. Musée scientifique, 46–67.

Westwood, J. O.
1852. Descriptions of new species of Cleridae, from Asia, Africa, and Australia. Proc. Zool. Soc. London **20**: 34–55, pls. (Annulosa) XXIV–XXVII.
1855. Descriptions of some new species of Cleridae, collected at Singapore by Mr. Wallace. Proc. Zool. Soc. London 23: **19–26**, plate (Annulosa) XXXVIII.
1875. Description of a new genus of clerideous Coleoptera, from the Malayan Archipelago. Trans. Ent. Soc. London 241–242, pl. 9, fig. 1.
1876. Description of some new exotic species of coleopterous insects. Trans. Ent. Soc. London 493–495, pl. 2.

White, Adam.
1849. Nomenclature of coleopterous insects in the collection of the British Museum, Part IV. Cleridae. London, British Museum.

Wollaston, T. Vernon.
1854. Insecta Maderensia, being an account of the insects of the islands of the Madeiran group. pp. XLIII, 634, pls. 1–13. London.

ILLUSTRATIONS

[Figures 1 to 21 show: *a*, antenna; *b*, labrum; *c*, maxillary palp; *d*, labial palp; *e*, claw; *f*, apex of tibia with tarsus. Figures 22 to 28 show thorax, ventral view, anterior coxæ dissected away. Figures 29 to 46 show scale or color pattern of left elytron. Figures 47 to 58 show terminal sclerites of abdomen of male; *d*, dorsal view; *l*, lateral view; *v*, ventral view.]

PLATE 1

FIG. 1. *Cylidrus wallacei* Thomson.
2. *Cladiscus sanguinicollis* Spinola.
3. *Tillus notatus* Klug.
4. *Gastrocentrum unicolor* (White).
5. *Neohydnus pallipes* Kraatz.
6. *Cyrtinoclerus cyrtinoides* sp. nov.
7. *Callimerus lateralis* Chapin.
8. *Brachycallimerus latifrons* (Gorham).

PLATE 2

FIG. 9. *Omadius indicus* Castelnau.
10. *Anthicoclerus anthicoides* (Westwood).
11. *Orthrius binotatus* Fischer.
12. *Phaeocyclotomus tapetum* (Gorham).
13. *Stigmatium bakeri* sp. nov.
14. *Coptoclerus sericeus* sp. nov.
15. *Tarsostenus univittatus* Rossi.
16. *Teneroides melanopterus* sp. nov.
17. *Necrobia rufipes* de Geer.

PLATE 3

FIG. 18. *Allochotes bakeri* sp. nov.
19. *Teneropsis sibuyanus* sp. nov.
20. *Tenerus magnus* sp. nov.
21. *Paratenerus mindanensis* sp. nov.
22. *Cladiscus sanguinicollis* Spinola.
23. *Phaeocyclotomus tapetum* (Gorham).
24. *Tillus notatus* Klug.
25. *Callimerus lateralis* Chapin.
26. *Neohydnus pallipes* Kraatz.
27. *Necrobia violacea* (Linnæus).
28. *Brachycallimerus latifrons* (Gorham).

PLATE 4

FIG. 29. *Callimerus princeps* Chapin.
30. *Callimerus bellus* Gorham.
31. *Callimerus fenestratus* Chapin.
32. *Callimerus intricatus* Chapin.

FIG. 33. *Callimerus schultzei* Schenkling.
34. *Callimerus gratiosus* Gorham.
35. *Callimerus flavus* Chapin.
36. *Callimerus albus* Chapin.
37. *Callimerus trifoliatus* sp. nov.
38. *Callimerus pulchellus* Gorham.
39. *Callimerus oculatus* Chapin.
40. *Callimerus basilanicus* Chapin.
41. *Callimerus octopunctatus* Heller.
42. *Callimerus lateralis* Chapin.
43. *Callimerus borneensis* Chapin.
44. *Callimerus bisoctonotatus* sp. nov.
45. *Callimerus albescens* Chapin.
46. *Brachycallimerus latifrons* (Gorham).

PLATE 5

FIG. 47. *Callimerus bakeri* Chapin.
48. *Callimerus luzonicus* Chapin.
49. *Callimerus lateralis* Chapin.
50. *Callimerus princeps* Chapin.
51. *Callimerus intermedius* sp. nov.
52. *Callimerus basilanicus* Chapin.
53. *Callimerus fenestratus* Chapin.
54. *Callimerus pulchellus* Gorham.
55. *Callimerus albescens* Chapin.
56. *Callimerus persimilis* Chapin.
57. *Callimerus flavus* Chapin.
58. *Callimerus gratiosus* Gorham.

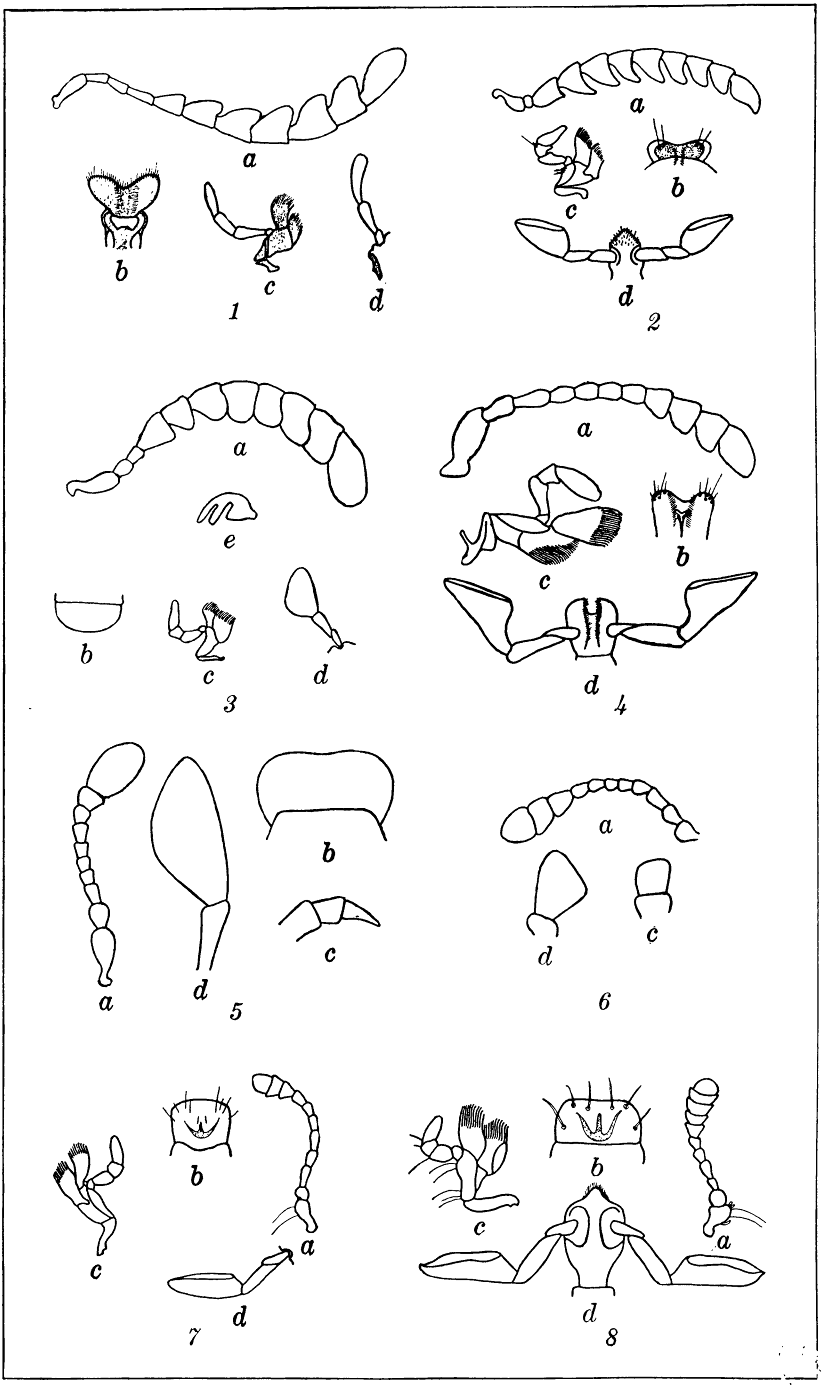


PLATE 1.

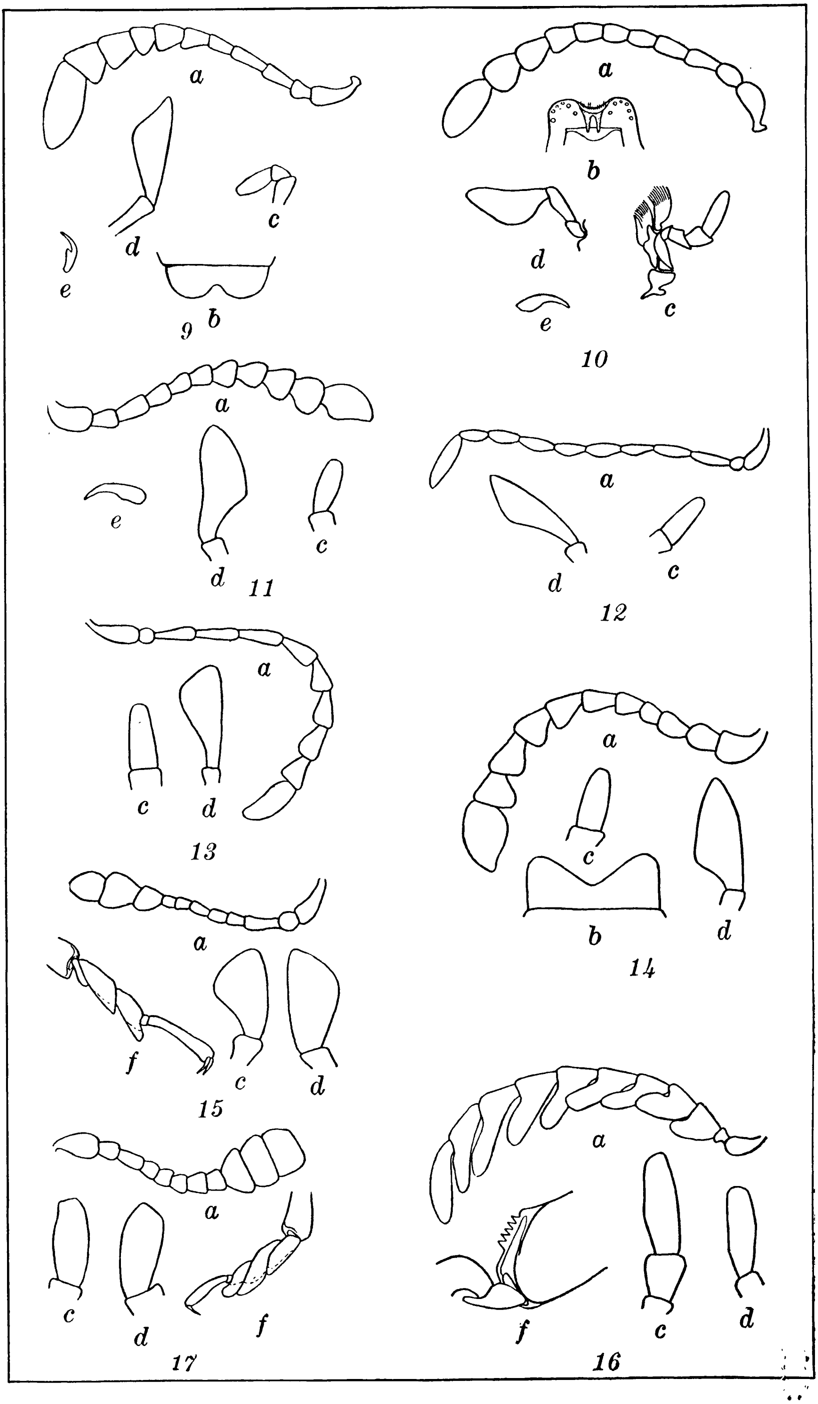

a
d
c
e
9 b
a
b
d
c
e
10
a
e
d
c
d 11
a
d
c
12
a
c
d
13
a
c
b
d
14
a
f
c
d
15
a
c
d
f
17
a
f
c
d
16

PLATE 2.

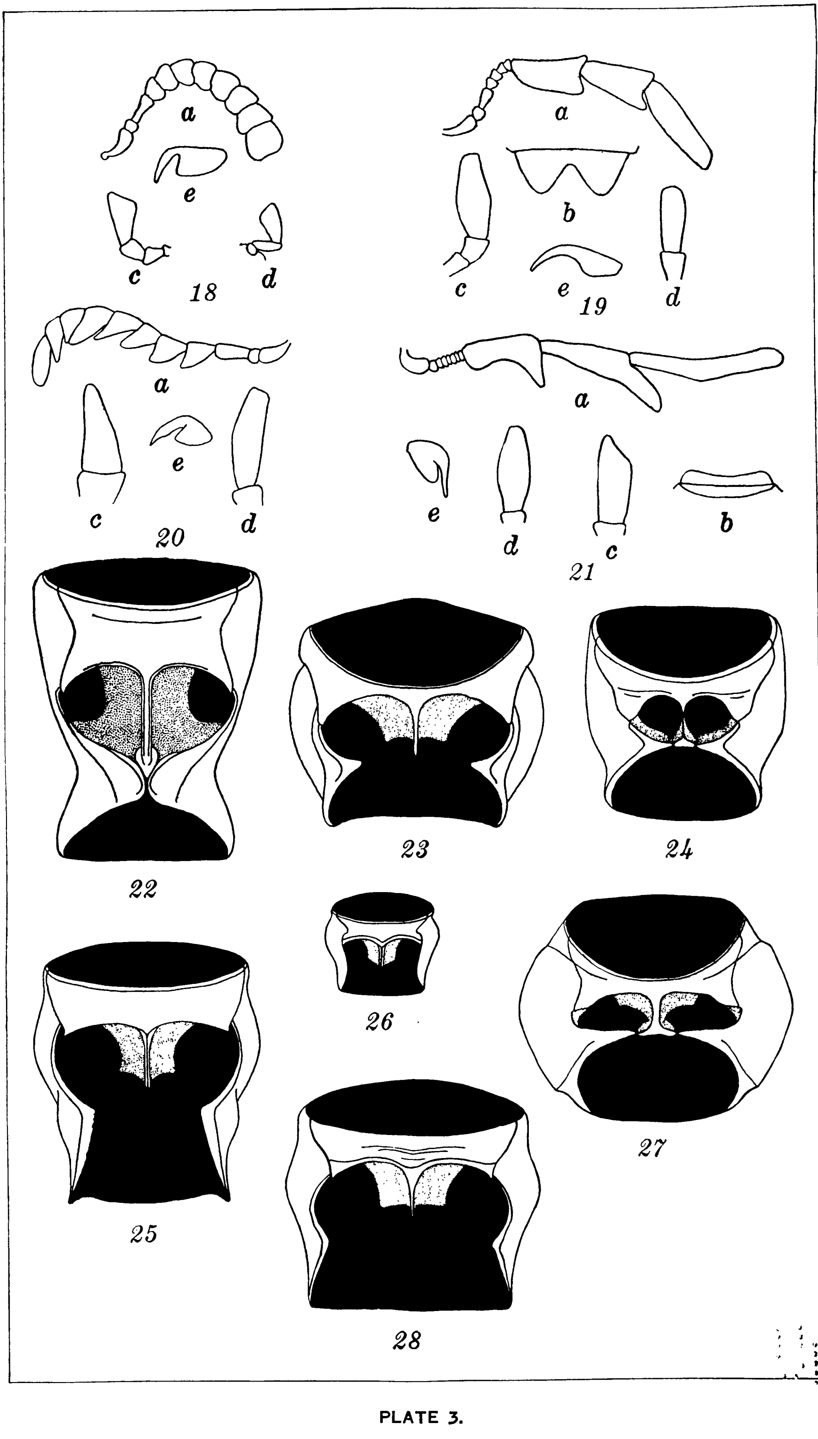


PLATE 3.

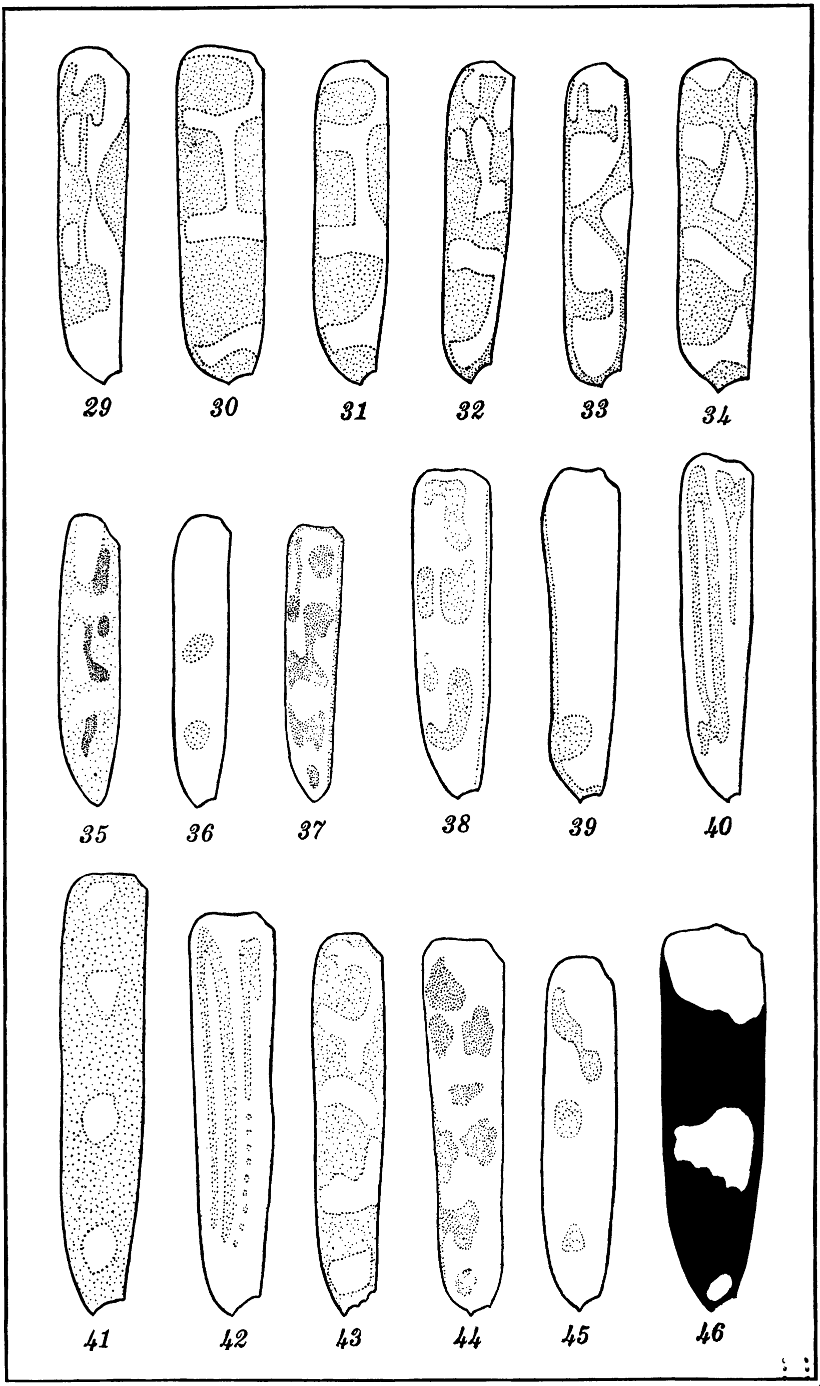


PLATE 4.

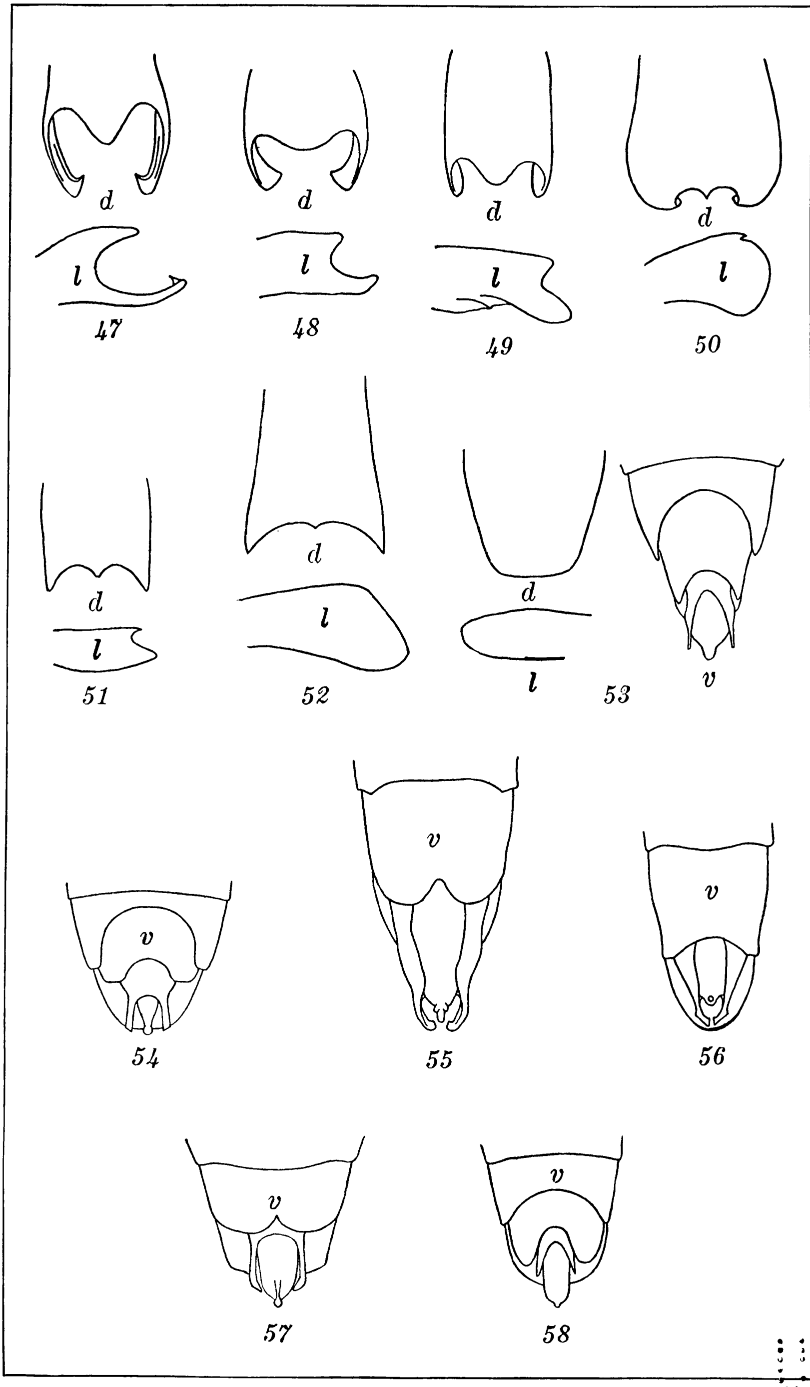


PLATE 5.

VOL. 25, NO. 3 SEPTEMBER, 1924

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1924

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science of the Government of the Philippine Islands

---

Manuscript intended for publication should be sent to the editor. One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Library, Bureau of Science, Manila, P. I.

The Journal is issued twelve times a year. The subscription price is 5 dollars, United States currency, per year. Single numbers, 50 cents each.

Subscriptions may be sent to the BUSINESS MANAGER, Philippine Journal of Science, Bureau of Science, Manila, P. I., or to any of the agents listed on the third page of this cover.

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 25 SEPTEMBER, 1924 No. 3

NEW PHILIPPINE ZYGOPINÆ, CALANDRINÆ, AND CRYPTODERMINÆ (CURCULIONIDÆ, COLEOPTERA)

By K. M. HELLER

Of the Zoölogical Museum, Dresden

ONE PLATE

Thanks to the collecting activity of Prof. Charles Fuller Baker, of Los Baños, I am able to give in this paper an essential contribution to the knowledge of the Zygopinæ, Calandrinæ, and Cryptoderminæ, subfamilies which have hitherto been given but little attention. I also acknowledge the kindness of Mr. W. Schultze, of Manila, to whom I am indebted for some interesting new species.

The new species and forms described are the following:

ZYGOPINÆ

Chirozetes lineolatus sp. nov.
Achirozetes kleinei g. et sp. nov.
Microzetes trochilus g. et sp. nov.
Mecopus coelestis sp. nov.
Phylaitis vidua sp. nov.
Calophylaitis principalis g. et sp. nov.
Metialma rufirostris philippinica subsp. nov.
Metialma straminea sp. nov.
Metialma laquearis sp. nov.
Nauphaeus decoratus sp. nov.

CALANDRINÆ

Otidognathus pictus nigricollis subsp. nov.
Omotemnus sanguinosus x-rufum subsp. nov.
Ommatolampus schultzei sp. nov.

CALANDRINÆ—Continued

Ommatolampus sulcirostris sp. nov.
Anathymus nigroscutellatus sp. nov.
Prodioctes surigaonis sp. nov.
Prodioctes surigaonis var. *nigripennis* var. nov.
Prodioctes unicolor sp. nov.
Sphenocorynus femoratus sp. nov.
Tetratopus scabrirostris sp. nov.
Periphemus albomaculatu sps. nov.
Diasthetus crassiusculus sp. nov.
Poteriophorus regulus sp. nov.
Cercidocerus sanguinipes sp. nov.
Pseudacanthorrhinus bipodex g. et sp. nov.
Sphenophorus nigrovittatus sp. nov.
Laogenia cylindricollis sp. nov.

CRYPTODERMINÆ

Cryptoderma longicolle sp. nov.
Cryptoderma mangyanum sp. nov.

ZYGOPINÆ

Chirozetes lineolatus sp. nov., ♀. Plate 1, fig. 1.

Niger, prothorace coriario, transverso, lineis tribus, tenuibus, scutello, elytris sutura spatiisque 1. ad 6. basi, lineola in spatiis 1. ad 3. et 5. atomisque, seriatis, in striis, punctato-striatis, lateralibus, ut corpore subter, in meta-episternorum dimidia parte apicali, abdomine utrinque macula nigro-denudata, basali, excepta, et tarsis albo-tomentosis; rostro apice subrufescenti, in dimidia parte basali striato-punctato; elytris spatio secundo adjacentibus latiore ac subconvexiore, irregulariter biseriato-, tertio-quinto in dimidia parte basali, sutura tota uniseriato-granulosis; pedibus subrufescentibus, parce griseo, tibiis apice nigro-pilosis. Long. 6, lat. 2.2 mm.

MINDANAO, Zamboanga Province, Dapitan (*Baker 14524*).

Form of elytra short trigonate as in *Daedania* Pascoe,[1] but the anterior femora slender as in *Chirozetes*. Brownish black, with the following white design: Three fine lines above on thorax, spare atoms at its sides, a basal band extending on each side to sixth stria and a short line behind middle of first, third, and fifth intervals of elytra, suture and scutellum entirely, metepisterna in posterior half, abdomen except a black patch on each side of base and tarsi white tomentose. Apical part of tibiæ black hairy.

Genus **ACHIROZETES** novum

Zygopinorum prope *Chirozetes* Pascoe. Antennae funiculo sex-articulato, clava articulorum linea separationis undulata. Femora valida, antica denticulis tres, primo longiore, postica dente trigono, magno, huius margine postico serrato-dentato. Tibiae posticae valde arcuatae. Scutellum subquadratum, margine postico subbilobato.

The principal characters distinguishing this new genus from *Chirozetes* Pascoe are the stout, basally slightly attenuate femora with a large, trigonate, serrate, and denticulate tooth which is serrate on the posterior margin, and the strongly curvate posterior tibiæ. Besides the species described herein *Chirozetes validipes* Heller[2] belongs to *Achirozetes*.

Achirozetes kleinei sp. nov. Plate 1, fig. 2.

Niger, capite, prosterno, prothorace basi lineisque tribus, lateralibus bi-interruptis, scutello, elytris sutura in triente

[1] Ann. & Mag. Nat. Hist. IV 7 (1871) pl. 15, fig. 1.

[2] Tijdschr. voor Ent. 37 (1894) 33, pl. 2, figs. 1 and 1*a*.

basali, spatio primo toto, spatio quarto quintoque basi exigue, hoc ante medium praeterea lineola ac in secundo triente macula, spatio sexto communi, punctiforme, ut corpore subter, pallide lutescenti-squamosis; rostro in parte apicali sat nitido ac subtiliter, reliquo opaco ac crebrius punctato; prothorace coriario, longitudine vix latiore; elytris striis punctato-striatis, bene definitis, sutura in dimidia parte apicali, spatio secundo, reliquis latiore, ut tertio quintoque remote seriato-granulatis. Long. 6, lat. 2.2 mm.

MINDANAO, Zamboanga Province, Dapitan (*Baker*).

Very similar to *Achirozetes validipes* and congeneric with it, but the prothorax without a middle carina and with a tolerably broad luteous basal band bent forward on each side. Suture in the first third, first interval entirely, a short line before the middle of fifth interval and a common spot in the second third of fifth and sixth intervals pale yellowish.

This species is interesting from the viewpoint of geographic distribution (the next related species is Papuan) and is dedicated to my friend Mr. R. Kleine, of Stettin, a very meritorious entomologist.

Genus **MICROZETES** novum

Zygopinarum prope *Chirozetes* Pascoe. Rostrum thoracis longitudine vix aequale, apice depressum. Antennae funiculo sex-articulato, clavam breviter ovatam versus sensim incrassato, articulis 3. ad 6. fortiter transversis. Prothorax transversus, spina prosternali utrinque armatus. Elytra brevia (latitudine e. sexta parte longiora) apice singula rotundata, sutura in dimidia parte basali impressa. Coxae anticae separatae. Sternitum abdominale, secundum, duobus sequentibus unitis aequilongum. Femora sat brevia, haud clavata, postica elytris tertia parte superantia, extus subcarinulata, antica dente, obtuso, armata. Tarsi postici (ut in genere *Chirozetes*) articulo primo reliquis unitis aequali, antici, maris, subtilissime fimbriati.

Differs from *Chirozetes* Pascoe chiefly by the very short, apically separately rounded elytra, the suture being impressed in the basal half by the funicle of antennæ which is thickened gradually in such manner that it passes over into the short ovate club, and by the sublinear femora the posterior of which show an indistinct carinula along the outside.

Microzetes trochilus sp. nov., ♂. Plate 1, figs. 3 and 3*a*.

Fuscescenti-niger, squamulis cervinis, partim setiformibus ac albidis tectus; rostro usque ad apicem depressiusculum, fortiter,

in dimidia parte basali seriato-punctato ac hic praeterea quinque-carinulato; antennis subrufescentibus funiculo articulis 2. ad 6. longitudine plus duplo crassiore, articulo 6. clava adpresso, hac crassitudine duplo longiore, subelliptica; prothorace transverso, spinis prosternalibus brevibus armato, crebre subrugoso-punctato, punctis squamulis cervinis, setiformibus, transverse directis, alteris maioribus, ellipticis, in maculis tribus basalibus et ad latera condensatis, munitis; scutello glabro, punctiforme; elytris maxima latitudine post humeros, prothorace latioribus, punctato-striatis, puncto singulo squamula, setiforme, cervinæ, repleto, spatiis minute seriato-granulatis, primo fere usque ad medium tres sequentibus (exterioribus) in circuiter minore albido-variegatis; corpore subter lutescenti, partim albido-squamoso, squamulis praesertim in metasterni lateribus magnis, longitudinaliter subimpressis. Long. 3, lat. 1.5. mm.

MINDANAO, Zamboanga Province, Dapitan (*Baker*).

In form somewhat similar to a small *Metialma* species, but in other respects nearly related to *Chirozetes*. Dark brown, covered with fawn-colored, partly white, setiform scales. Rostrum strongly punctate to apex, in the basal half with fine carinulæ. Prothorax covered sparingly with transversely directed, setiform, fawn-colored scales and larger, elliptic ones, the latter forming three densely squamose basal patches. Elytra broadest behind the shoulders, broader than the thorax, punctate-striate, each puncture filled with a more saturate fawn-colored bristle-like scale, intervals finely and remotely seriate granulate, the four inner varied with white in such manner that there is formed an indistinct triangular whitish area, reaching to the middle of the suture and on each side as far as to the fifth stria.

Mecopus coelestis sp. nov., ♀.

M. spinicolli Pascoe affinis, sed prothorace lateribus ante medium antrorsum rotundato-convergentibus, apice minus abrupte coarctato; elytris plus elongatis ac attenuatis; femoribus posticis multo longioribus, signaturis squamosis similiter dispositis, sed cobaltinis; rostro breviore, minus distincte carinulato; antennis funiculo tenuiore, clava plus elongata; prothorace rugoso-granulato, carina dorsali ante abbreviata, manifesta; scutello oblongo, nigro-velutino; elytris dorso depressis, spatiis, ab stria quarta, carinatis ac sat remote aspere granulatis; femoribus posticis dimidia parte elytris prominentibus, tibiis posticis medio fortiter incrassatis, tarsis omnibus articulo primo secun-

doque supra, corpore subter fere toto, cobaltino-squamosis, macula communi laterali in metasterno episternisque, in elytris oblique continuata, nigra, excepta. Long. 12, lat. 5.3, long. femor. post. 7.5 mm.

MINDANAO, Agusan Province, Butuan (*Baker*).

Very closely allied to *M. spinicollis* Pascoe from Java, but distinguished by the much longer club of antennæ, the form of prothorax, the sides of which are slightly rounded and convergent in the apical half, the much longer posterior femora, the strongly thickened hind tibiæ, and the pale blue instead of ashy squamosity.

Phylaitis vidua sp. nov. Plate 1, fig. 4.

Aterrima, prothorace linea mediana angulisque posticis, scutello, vittiforme, elytris sutura in primo triente maculaque utrinque anteapicali, subquadrata ac subdentata atomisque numerosis ad suturam, secundum strias elytrorumque ad apicem, ut corpore subter, albo-squamosis; rostro prothorace paulo longiore, dimidia basali quinque-subcarinulato ac punctato-striato; antennis subrufescentibus, funiculo articulo secundo primo, tertio sua crassitudine paulo longioribus, sequentibus inter se fere aequalibus; prothorace transverso, dense subgranuloso-punctato; elytris prothorace vix latioribus, striis punctatis, in triente apicali evanescentibus, sutura post medium manifeste elevata, ut spatiis 2. ad 4. remote uni-seriato-granulosis, spatio quinto basi deprimato; femoribus anticis subfusiformibus, posticis dente magno, trigono, armatis; corpore subter, praesertim in prosterno, squamulis maioribus, breviter ellipticis, tecto. Long. 4.5, lat. 1.8 mm.

MINDANAO, Zamboanga Province, Dapitan (*Baker 14523*).

In consequence of the contiguous anterior coxæ, comparatively short anterior subfusiform femora, short third joint of antennæ, and large triangular tooth of posterior femora, this species belongs to *Phylaitis* in spite of its similarity to a *Mecopus* female. Color black, with the following markings: Posterior angles and the middle line of prothorax, scutellum (which is twice as long as broad) entirely, the first third of suture densely, the remaining elevated part sparingly (and more setose), a subapical patch bidentate in front and behind on each side of elytra, extending from first to fourth stria, numerous seriate atoms, along the striæ, and in the apical part white squamose. Underside wholly and densely white squamose, the somewhat reddish legs more sparingly white setose.

Genus CALOPHYLAITIS novum

Zygopinarum. Rostrum robustum, prothorace vix longius, basi sectione transversa subpentagonali, dorso quinque subcarinulatum ac striato-punctatum. Antennae rostri apice quam medio propiore insertae, funiculo sex-articulato, apicem versus sensim incrassato. Prothorax basi truncatus, lobis ocularibus nullis. Scutellum magnum, subquadrato-rotundatum. Elytra fere conica, apice rotundato-truncata, decem-striatis. Mesepimera angusta, etsi adscendentia. Sternitum abdominale secundum tertio vix longius. Coxae anticae separatae. Femora dentata, postica elytra haud superantia. Tibiae haud curvatae.

The comparatively stout rostrum and the short second ventral segment separate this genus from all other genera of Zygopini without ocular lobes and with six-jointed funicle. Its form is similar to *Phylaitis* near which it may be placed.

Calophylaitis principalis sp. nov.

Nigra, supra squamulis plus minusve setiformibus, subter squamis sat magnis tecta, capite post oculos thoraceque, margine basali anguste albido excepto, cinnabarino-squamosis, vertice minute granulato; elytris sat tenuiter profundeque subpunctato-striatis, fascia basali, ut scutello, griseo-, fascia mediana, arcuata (post concava) guttaque suturali, apicali, stria secunda determinata, niveo-squamosis. Long. 4, lat. 1.5 mm.

MINDANAO, Agusan Province, Butuan (*Baker*).

The cinnabar-red thorax and the black elytra with a median white arcuate crossband make this species easily recognizable. The margin of the eye is slightly angulate below (not perfectly rounded), the antennæ are inserted nearer to the apex than to the middle of rostrum, the funicle is densely white setose, the club black. Scutellum subquadrate, extending on each side to the first elytral stria and like the intervals of elytra with a fine granulation, ordinarily hidden by the squamosity.

Metialma rufirostris [3] philippinica subsp. nov.

Differt a specie typica: Statura minore, femoribus posticis longioribus, sternito anali, maris, ultimo utrinque longius laciniato-producto, corpore subter squamulis, praesertim metasterni in lateribus acute lanceolatis (in sp. typica ellipticis) ac longitudinaliter subimpressis. Long. 2.1 ad 2.5, lat. 1.2 ad 1.4 mm.

LUZON, Laguna Province, Los Baños, Mount Maquiling: Tayabas Province, Malinao (*Baker*).

[3] Faust, Stettiner Ent. Zeitg. 44 (1883) 482.

As in Faust's *M. rufirostris,* described from a single specimen from Burma, the new subspecies has the apical half of rostrum, the antennæ, and the tarsi ferrugineous and the squamosity with the same pattern and color. The only differences, besides the much smaller size (2.1 to 2.5 millimeters as opposed to 3) are: The laterally longer produced anal segment of male, the longer acute lanceolate (instead of elliptic) scales, especially on the sides of metasternum, which are impressed, and the longer posterior femora.

Metialma straminea sp. nov., ♂, ♀.

Niger, antennis, totis, tarsisque apice, ferrugineis, supra sat dense stramineo-tomentosa, prothorace disco macula transversa aut gemina, rare deficiente nigricante, elytris parce nigricante-variegatis; prothorace angulis posticis margineque, postico, ante scutellum, scutello, ut corpore subter, albo-squamosis, sternito abdominali tertio quartoque medio utrinque nigro-maculatis, sternito anali, maris, utrinque albo-laciniato. Long. 4.5, lat. 3 mm.

LUZON, Laguna Province, Los Baños, Mount Maquiling (*2632*); Mount Banahao (*Baker*).

Black, antennæ and tarsi, especially the last joint, ferrugineous; upper side covered all over with a hairy straw-colored tomentum, a little black mottled on the elytra; prothorax with a transverse, blackish discal patch, sometimes divided, or wanting, sometimes also a small one of the same color on the anterior angles, then a dot on the posterior angles and on the scutellar lobe, the whole scutellum, apex of suture, and underside of body pure white, a black dot on each side of the middle line of third and fourth ventral segments excepted.

Metialma laquearis sp. nov., ♂, ♀.

Nigra, antennis, clava nigra excepta tarsisque apice nigris, parce, sutura apice densius albido-setosa, plagis prothoracalibus ut punctis variegatim dispositis in elytris, nigro-denudatis; prothorace maculis duabus discoidalibus approximatis (aut subconvexis), alterisque utrinque basalibus, minoribus, conjunctis denudato-nigris, extrinsecus vitta, albida, medio constricta, aut interrupta, determinata usitatim basi apiceque laqueato-dilata, maculam rotundatum ad marginem apicalem et basalem circumcingente; pygidio maris carinato, utrinque plus minusve, rare toto, corpore subter omnino albido-tomentoso, meta-episternis interdum nigricantibus. Long. 4 ad 4.5, lat. 2 ad 2.4 mm.

LUZON, Laguna Province, Mount Maquiling, Los Baños (*613*): Tayabas Province, Malinao. MINDANAO, Zamboanga Province, Dapitan (*Baker*).

A black, whitish tomentose species, variegate on elytra, with reddish antennæ and black club. The whitish fine lateral vitta on prothorax in front and at the base usually similarly dilated. Pygidium of male carinate, anal sternite on the apex impressed, hardly produced on each side.

Key to the Philippine species of the genus Metialma Pascoe.

a^1. Rostrum ferruginous on the apical half.
- b^1. Tibiæ blackish.
  - c^1. Upper side with unicolorous yellowish tomentum. **M. obsoleta** Heller.
  - c^2. Upper side with creamy dots, three on base of prothorax, and one on apex of suture. Length at most 2.5 millimeters. **M. rufirostris philippinica** subsp. nov.
- b^2. Tibiæ and tarsi yellowish red, elytra with a broad cretaceous sutural stripe extending to third stria and dilated gradually toward base to fifth stria **M. gilvipes** Heller.

a^2. Rostrum at most dark red at apex.
- b^1. Antennæ with club black, the rest ferruginous.
  - c^1. Pygidium on each side or entirely covered with whitish, carinate in male **M. laquearis** sp. nov.
  - c^2. Pygidium black, in the male without a median carina, but in this sex on the first ventral segment with a transverse, denser, and yellowish tomentose patch in the middle **M. nigritana** in litt.
- b^2. Antennæ entirely red.
  - c^1. Pygidium, metepisterna, and abdomen unicolorous, covered with whitish tomentum **M. straminea** sp. nov.
  - c^2. Pygidium entirely black or only on the apical half; metepisterna in the anterior part, the third and fourth ventral segments on each side of the middle line with a more or less distinct black spot. Java. MINDANAO, Surigao Province, Surigao: Lanao Province, Kolambugan: Agusan Province, Butuan (*Baker 4508*). LEYTE, Tacloban (*Baker 15029*) **M. ignorata** Faust.[4]

Nauphaeus decoratus[5] sp. nov.

Niger, opacus, antennis subsanguineis, prothorace subirregulariter punctato, disco subfuscescenti, lineis isabellinis, tenuibus, his ornatus: in prothorace utrinque duabus longitudinalibus,

[4] Stettiner Ent. Zeitg. 44 (1883) 483.

[5] The sixth Philippine species of this genus; the others are *simius* Faust, Mindanao, Kolambugan (*14673*); *linearis* Heller, Stettiner Ent. Zeitg. (1908) 179, Borneo, Luzon, Laguna Province, Magdalena (*1751*); *sexmaculatus* Heller, Philip. Journ. Sci. § D 8 (1913) 146; *manobo* Heller, Philip. Journ. Sci. 19 (1921) 620, Mindanao, Zamboanga (*7318, 7319*); and *carbonarius* Heller, op. cit. p. 619, Luzon, Tayabas Province, Malinao (*Baker*).

basi conjunctis ac remotis, medium versus valde approximatis, dein apicem versus divergentibus, linea interiore prothoracis marginem anteriorem attingente, exteriore post sulcum latero-apicalem deorsum curvata ac coxis anticis attingente; in elytris, minute parceque granulatis spatioque secundo reliquis convexiore ac latiore, una baseo-marginali, altera baseo-submarginali, utrinque ad humeros atque ad scutellum conjunctis, area transversa dorso-basali majore, altera infrahumerali minore cingentibus, linea mediana, transversa, undulata, ad suturam et ad striam quintam breviter antrorsum inflexa, extus utrinque anulis duabus minutis, interdum obsoletis, conjunctis, deinde linea circulari laterali ante secundum trientem, inter striam septimam et nonam, altera inter primam et quartam, ante declivitatem, post lineis duabus parallelis, marginem apicalem attingentibus, exmitentibus; corpore subter albido, metasterno sternitisque 1° ad 4° lateribus, plus minusve roseo-, sternito abdominali secundo utrinque medio, tertio quartoque fere totis, nigricanti-, sternito anali femoribusque cinereo-squamosis. Long. 10.5, lat. 4.9 mm.

MINDANAO, Agusan Province, Butuan (*Baker 18740*).

A dull black species, very similar in size and form to the other species of the genus but the elytra and the shoulders a little broader than the base of prothorax, both ornamented with delicate ocherous lines: Two on each side along the disk of prothorax, very approximate in the middle and diverging toward the base and apex, two transverse lines at the base of elytra, confluent on the shoulders, one transverse undulate line near the middle, between the suture and the fifth stria, and two circular lines, one at the sides before the second third and between the seventh and ninth striæ, the other on the declivity, between the first and fourth striæ, sending out posteriorly two parallel lines toward the apical margin.

CALANDRINÆ

Otidognathus pictus[6] **nigricollis** subsp. nov.

Niger, elytris ferrugineis, limbo suturali tenui, macula utrinque subapicali margineque apicali (fere ut in *picto*) in sutura spatioque primo producta, nigris; metasterno lateribus, mesosternis, meso-epimeris meta-episternisque singulis macula mediana, rufa; rostro, maris, longitudinaliter ruguloso, haud seriatim tuberculoso. Long. 14, lat. 6.8 mm.

[6] Philip. Journ. Sci. **19** (1921) 623, pl. 3, fig. 10.

LUZON, Ilocos Norte Province, Burgos (*Schultze*).

Several specimens strikingly uniform in color coming from Ilocos Norte seem to be only a local race of *O. pictus* Heller, differing from this species by the entirely black prothorax and pygidium and the reddish elytra, each of which bears only a black subapical spot and a common apical band, similar to that of *O. pictus*, produced on the suture and first interval. Sides of body bare (perhaps the golden yellow velvet is worn off).

Omotemnus sanguinosus x-rufum subsp. nov., ♂.

Differt a specie typica: prothorace utrinque vitta, basi apiceque abbreviata, antrorsum attenuata; elytris fascia postmediana, rubra, in similitudinem x. litterae ad suturam antrorsum, dein ad marginem lateralem extrorsum, currente. Long. 20, lat. 8.2 mm.

MINDANAO, Lanao Province, Iligan (*Baker*).

The typical specimen is a female from Mount Maquiling, Luzon; the male described here, from Iligan, Mindanao, has a similar but shorter rostrum, a shorter, laterally more-rounded prothorax, and a shorter more-obtuse pygidium; moreover, the prothorax shows a black vittiform patch on each side of the disk and the postmedian red part of elytra is extended in front along the suture, running thence toward the subhumeral patch, forming in this manner a red x-shaped figure. Since both specimens are unique, it is impossible to say whether the described form is a local race or a variety.

Ommatolampus schultzei sp. nov., ♀. Plate 1, fig. 5.

O. haemorrhoidali Wied. statura similis, pygidio, apice haud impresso, ut corpore reliquo, maxima parte nigris, maculis sanguineis his ornatus: prothorace utrinque post medium gutta, interdum deficiente, elytris macula antehumerali, transversa, vitta obliqua (e maculis oblongis duabus, subconvexis, formata) spatii primi in primo quarto incipiente ac marginem lateralem versus ad sternitum primum ventralem currente, macula subapicali inter striam tertiam et quartam, corpore subter maculis minoribus, una utrinque in prosterno, una laterali in mesosterno, una, transversa, mediana, in mesepimeris et una subapicali in meta-episternis; ♀ pygidio apice haud impresso. Long. 29, lat. 8.5 mm.

LUZON, Nueva Ecija Province, Caraballo Mountains (*Schultze*).

Rostrum, in comparison with *O. haemorrhoidalis* Wied., shorter, and higher in vertical extension, the apex transversely

subrectangularly excised. Elytra broader than in the above-mentioned species, with striæ 3 and 4 approximate at the base; striæ hardly punctate, a transverse patch before the shoulder, an oblique band beginning in the first quarter of second stria, running on the lateral margin to the first ventral segment, and a subquadrate, subapical patch between the third and eighth striæ, red; of the same color are a spot on each side of prosternum, on the sides of metasternum, on mesoepimera and met-episterna, the latter of which is subapical. First ventral segment behind the posterior coxæ with a submarginal stria, touching the met-episterna exteriorly.

Ommatolampus sulcirostris sp. nov., ♂. Plate 1, fig. 6.

O. parastasiodi Heller[7] affinis, supra sanguineus, plaga utrinque oblonga thoracali, elytris fascia basali, margine postico, dentato, ad suturam perpendiculari, scutello maculaque postscutellari, fascia mediana, paulo transversa, inter striam tertiam et marginem lateralem, margine apicali, inter stria tertia utrinque antrorsum dilatata, pygidio, apice impresso, macula utrinque, rufa, basali excepta, ut corpore subter, prosterno, sternito anali, femoribus tibiisque rufis exceptis, nigris; rostro dorso linea tenui impressa, sternito abdominali primo sulco postcoxali via indicato. Long. 30, lat. 9 mm.

MINDANAO, Surigao Province, Surigao (*Schultze*).

Similar to *O. parastasiodes* Heller but rostrum dorsally with a fine impressed line, elytra with a black basal band, the denticulate posterior margin of which is perpendicular to the suture, as is the anterior margin of the subquadrate medial patch. Pygidium black, a basal spot on each side red. First ventral segment with a barely indicated postcoxal line.

Anathymus nigroscutellatus sp. nov., ♀. Plate 1, fig. 7.

Niger, prothorace, fortiter punctato, vittis tribus, nigris, exceptis, elytris in sutura, spatio primo secundoque vitta, basin versus usque ad striam .quartam dilatata, macula mediana, oblongo-elliptica, inter striam quintam nonamque, pygidio pedibusque, genubus tarsisque, nigris, exceptis, rufis; pygidio lateribus vitta marginali, corpore subter maxima parte, albopruinosis; femoribus posticis (in ♀ !) sterniti anali dimidium superantibus. Long. 10.5, lat. 2.8 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

[7] Notes Leyden Mus. 18 (1897) 245.

In the genus *Anathymus* Pascoe,[8] as in others, the male differs from the female by a strongly punctate rostrum which, in the latter, is nearly smooth, whereas in differentiating the species the form of the pygidium is an important character. In *A. singularis* Pascoe, this is simply convex lengthwise in the male; in *A. meyeri* Faust[9] a little cristately produced beyond and above the apex in the male, simply convex in the female; in *A. coloratus* Faust, male, acutely conical, female, obtusely produced; in a hitherto undescribed Formosan species (*A. tricolor* Heller in litt.) it is similar in both sexes; in the female of *A. nigroscutellatus* sp. nov., but slightly produced above the apex. The color of the last-named species is black, underside whitish pruinose, prothorax strongly punctate, red except for three black vittæ; of the same color are a broad sutural stripe, dilated toward the base as far as the fifth stria, an oblong elliptic patch on each elytron between the fifth and ninth striæ, and the femora and tibiæ except at apex.

Prodioctes surigaonis sp. nov., ♀. Plate 1, fig. 8.

P. rubrovittato Heller[10] similis, sed rostro breviore, minus arcuato, prothorace vittis nigris tenuioribus, scutello nitido, elliptico, elytris spatiis alternatis (quarto quam tertio fere duplo) latioribus, stria 1. ad 4. punctato-striatis, tertia quarta valde approximata, 5. ad 7. seriato-punctis, sutura in dimidia parte apicali elevata, vittis nigris his ornatis: una suturali, suturam spatiumque primum, hunc basi apiceque exceptis, occupante, altera laterali, inter striam quintam et octavam, apice usque ad striam secundam introrsum curvata, tertia, marginali, extra striam nonam; praeterea pygidio lineola basali, mediana, sternito secundo, quartoque macula mediana, tertio quartoque praeterea altera, laterali, sternito anali lineola mediana, nigris; femoribus omnibus dentatis. Long. 9.5, lat. 3 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

Prodioctes surigaonis var. **nigripennis** var. nov., ♂.

Differt a specie typica: elytris nigris, humeris rufomaculatis, abdomine haud nigro-maculato.

Apparently the two specimens before me, from the same locality, different in the color of the elytra, are the two sexes

[8] Ann. Mus. Genova II 2 (1885) 299.
[9] Stettiner Ent. Zeitg. 59 (1898) 207.
[10] Philip. Journ. Sci. § D 10 (1915) 234.

of the same species. The male *P. rubrovittatus* Heller is somewhat similar in color to the female of *surigaonis* here described, but may be at once distinguished by the linear scutellum and by the very finely punctate rostrum which in *P. surigaonis* var. *nigripennis* is very strongly and densely somewhat rugulose punctate throughout. The principal difference between the species consists, however, in the very approximate third and fourth striæ and the broad convex interval between the fifth and sixth striæ. The typical specimen, a female, is red; three lines, a median line, two lines on the lateral margin of prothorax, a sutural, a latero-marginal and a submarginal stripe, between fifth and eighth striæ, black; the latter stripe curved inward at the apex as far as to the second stria and not touching the humeral callosity. The variety *nigripennis* differs in having the black elytra with only a red humeral spot, and the abdomen not black maculate.

Prodioctes unicolor sp. nov., ♂.

A *P. alternanti* Chevrolat aegre sed certe discernendus, unicolor rufus; rostro (♂) tenuiore usque ad apicem crebre subruguloso-punctato; antennis funiculo tenuiore, articulo secundo crassitudine distincte longiore; prothorace disco subdeplanato; scutello minore; elytris in eodem modo quam in *alternanti*, spatio quarto convexo ac latiore; pygidio (♂) apice subbituberoso. Long. 11, lat. 4.5 mm.

MINDANAO, Surigao Province, Surigao (*Baker 14805*).

The long thin rostrum, which is as long as the prothorax, the finely and densely somewhat rugose punctate rostrum of the male, the disk of prothorax flattened in the basal half, and the uniform sanguineous color of the body are the chief characters for distinguishing this species from the similar *P. alternans* Chevrolat.

Sphenocorynus femoratus sp. nov., ♂, ♀.

T. feae Faust [11] sat affinis, unicolor sanguineus, subter albido-pruinosus, rostro maris toto, feminae basi solum, rude punctato, prothorace dorso longitudinaliter depressiusculo, scutello nigro, oblongo-cordiforme, acuminato; elytris subtiliter punctato-striatis, stria 5. ad 9. striato-punctatis, stria decima (in generis specie typica, *sericans*, in triente basali explicata) tota obliterata, spatio secundo adjacentibus vix, quarto his multo

[11] Ann. Mus. Genova 34 (1894) 332.

latioribus ac convexiore; pygidio latitudine basali longiore, mesosterno lobo intercoxali fere quadrato, margine postico medio anguste profundeque exciso, epimeris, episternis posticis metasternoque sat remote ubique punctatis, hoc praetera utrinque sulco, coxis intermediis post circumcingente, femoribus, apice nigris, posticis sterniti anali apicem attingente. Long. 15, lat. 5.2 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

This species differs from the typical species of the genus by the longer and more deeply notched intercoxal process of the mesosternum; the more finely striate, smaller, and less-depressed elytra; the longer pygidium; and the longer posterior femora. Color sanguineous, only the small cordiform acuminate scutellum and the tips of femora black. The inner four striæ of elytra punctate-striate, the others seriate, partly indistinctly punctate, interval between fourth and fifth striæ broadest and convex. Posterior femora attaining the apex of anal segment.

Tetratopus scabrirostris sp. nov., ♂, ♀.

Oblongus, rufus, supra linea mediana prothoracali scutelloque, subtus, margine antico lato prosternali excepto, lateribus femoribusque apice plus minusve nigris; *T. feae* Faust [12] similis, sed rostro paulo longiore ac crassiore in dimidia parte apicali minus attenuato, maris per totam longitudinem aspero-ruguloso, feminae perrude, apicem versus paulo subtilius punctato; antennis nigris, articulis 3 ad 6 longitudine duplo latioribus, clava latitudine duplo longiore, basi subpedunculato-attenuata; prothorace latitudine longiore (3.7: 4.5), margine laterali in dimidia parte basali subconcavo; scutello ovato (in *feae* trigono); elytris apice singulis rotundatis; pygidio rude punctato, maris apice truncato aut subbituberculato; mesosterno inter coxas intermedias bilobato; sternito ventrali primo medio (maris subconcavo) rude crebreque punctato. Long. 12, lat. 3.8 mm.

MINDANAO, Agusan Province, Butuan (*19511*).

Tetratopus scabrirostris ab. **monomorphus** ab. nov.

Maior, long. 13, lat. 4 mm., unicolor rufo-ferrugineus. (*19512, 19509*).

The smaller species of the genus *Tetratopus* (less than 16 millimeters long) can be distinguished as follows:

a^1. Intercoxal process of mesosternum sinuate, first ventral segment finely and remotely punctate, club of antennæ but little longer than broad.

[12] Ann. Mus. Genova II 14 (34) (1894) 332.

b^1. Sides of first and second ventral segments somewhat irregularly and remotely punctate, elytra black; length, 10 millimeters. (Pegu.) **T. semiruber** Faust.[13]

b^2. Sides of first and second ventral segments equally and rather densely punctate, elytra red with few black spots. (Burma.) **T. feae** Faust.

a^2. Intercoxal process of mesosternum bilobate.

b^1. Metasternum strongly but remotely punctate, anteriorly with a deep acute angularly produced postcoxal furrow, first ventral segment with few remote punctures........................... **T. femoralis** Heller.

b^2. Metasternum finely punctate, without a deep postcoxal furrow, first ventral segment coarsely and densely punctate.

c^1. Middle line of prothorax and sides of body more or less black. (Mindanao.).. **T. scabrirostris** sp. nov.

c^2. The whole body, except the blackish episternal suture of metasternum, brick red. (Mindanao.) **T. scabrirostris** ab. **monomorphus** ab. nov.

Periphemus albomaculatus sp. nov., ♂.

Niger, prothorace in angulis anticis posticisque, elytris utrinque spatio tertio basi, macula altera in suturae medio, transversa, usque ad striam tertiam extensa, pygidio, carinula mediana nigra, excepta, meta-episternis segmentisque abdominalibus tertio quartoque, albotomentosis; rostro paulo arcuato, prothorace breviore, sat remote punctato, dorso vitta mediana levi, fronte bicristata; funiculi articulo primo, subsphaerico, secundo, oblongo-conico, distincte breviore; prothorace subcylindrico, latitudine fere duplo longiore, fortiter punctato, disco in medio carinula brevissima, scutello elongato, acuminato; elytris subcylindricis, latitudine vix duplo longioribus (3.6: 6), sat fortiter punctato-striatis; pygidio carina, mediana, post compressa, ultra apicem producta. Long 6.5, lat. 1.8 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

A small black species, ornamented above with white spots. Rostrum slightly arcuate, moderately densely punctate, with a broad smooth dorsal stripe. Antennæ dark reddish. Front with two anteriorly convex crests. Prothorax white spotted in each angle. Elytra at the base of third interval with a short stripe, a common, transverse sutural spot, extending as far as to the third stria; pygidium, except a median vitta, metasternum, and the third and fourth ventral segments cretaceous-tomentose.

Diasthetus crassiusculus sp. nov., ♂, ♀. Plate 1, figs. 11, 11*a*.

D. semivelutino Chevrolat affinis ac similiter convexus, sed antennarum clava latitudine longiore (1.3 : 1.5), elytris sine

[13] Deutsche Ent. Zeitschr. (1898) 331.

plagis nigro-velutinis, spatiis convexioribus; corpore subter maris metasterno in dimidia parte posteriore area rude punctata ac breviter fulvo-setosa. Long. 13 ad 17, lat. 5.8 ad 7.5 mm.

MINDANAO, Zamboanga Province, Dapitan (*Baker*). Philippines [Luzon?] (*O. F. v. Möllendorff*).

Diasthetus semivelutinus Chevrolat, from New Caledonia, and *D. crassiusculus* sp. nov. are the only species of the genus with similarly convex elytra, but the latter has no velvet black patches on the elytra, at the base more-convex shining denudate intervals, a longer antennal club, and in the male the metasternum in the posterior half strongly punctate and set with short stiff hairs.

Poteriophorus regulus sp. nov., ♀. Plate 1, fig. 13.

Albus, prothorace latitudine paulo longiore (7.1 : 8 mm.), dorso vittis tribus, mediana latiore, lateribus maculis duabus, vittiformibus, inframarginali basi apiceque, supracoxali solum basi abbreviatis, nigris; scutello vittiformi, sulcato, albo, apice acuminato; elytris latitudine paulo sesqui longioribus (8.5 : 13 mm.), nigris, margine basali vittisque inter striam secundam tertiamque altera inter sextem et septimam, in elytrorum primo triente, in rami latioris modum, confluentibus, in secundo triente utrinque cruciatim dilata suturam marginemque lateralem attingente, sutura anguste, in triente apicali vix albidis; pygidio albo, vitta mediana nigra; corpore subter albo, macula, lata, ad suturam metaepisternalem, altera in sternitis abdominalibus 2. ad 4. communi, sublaterali, unica apicali in sternito anali, nigris; prothorace omnino (latera versus haud fortius) subtiliter remoteque, metaepisternis sternitoque anali lateribus crebrius punctatis, lineis sulcatis duabus postmedianis in metasterno remotius ac plus parallelis quam in *P. niveo-punctato*. Long. 23.5, lat. 8.5 mm.

POLILLO, unicum.

A fine species, characterized by the white and black design (shown in the figure) agreeing in form with *P. fuscovarius* Waterhouse and *P. bowringi* Waterhouse rather than with *P. niveus* Gyllh., the type of the genus. The single female before me has the rostrum as in the species mentioned, carinate before the antennal scrobes and sulcate along the middle of the swollen and pale velvet-clothed basal part. All the punctures of the body are, as in *bowringi*, of small size, without a circle, except the punctures on the black elytral spots. Scutellum elongate, white acuminate. Elytra deeply furrowed along base. Pygi-

dium sparingly punctate. Intercoxal process of mesosternum deeply and very acutely angularly incised on apex. Metasternum in posterior half medially with two remote and parallel, impressed lines. Metepisterna as in *bowringi,* abundantly punctate, along the anterior part of suture with a large black patch common to metasternum. Sides of abdomen with a broad black lateral stripe extending from the half of second over the base of fifth ventral segment.

Cercidocerus sanguinipes sp. nov., ♂.

C. fabrili Gyllh. simillimus, sed differt maris antennarum clava multo minus transversa (paulo minus quam in *x-rufo* Chevrolat), funiculi articulo secundo plus transverso, prothorace minus elongato, disco concavo, carinula mediana, sat minute crebreque punctato, margine basali, extrorsum dilatate, scutelloque, vittiforme, albo-pruinosis; elytris subtilius punctato-striatis, plaga mediana rotundata nigro-velutina, maiore; femoribus sanguineis subclavato-incrassatis. Long. 11, lat. 5.4 mm.

MINDANAO, Davao Province, Davao (*Baker*).

Like *C. fabrilis* Gyllh., above black, with a black but larger and more-roundish black velvety patch in the middle of each elytron; the femora, except the black apex, red; club of antennæ much less transverse (in male) than in *C. fabrilis,* its breadth less than the length of scape; elytra more finely punctate-striate.

Genus **PSEUDACANTHORRHINUS** novum

Calandrinorum prope *Sphenocorynus* Schönherr. Rostrum breviusculum, apice subincrassatum ac paulo curvatum. Antennae clava asymmetrica, compressa, subtransversa, parte spongiosa, apicali, tenui, vittiforme. Scutellum lineare. Elytra oblongo-elliptica, dorso convexa, apice subtruncato-rotundatis. Pygidium transversum. Femora mutica, antica brevia, validiuscula. Tibiae posticae longitudinaliter carinulatae. Mesosternum lobo intercoxali subquadrato, ultra coxarum intermediarum centrum producto. Sternita abdominalia tres intermedia, margine postico extrorsum acutanguloso.

Allied to *Sphenocorynus,* from which it differs by the short, subquadrate, compressed, asymmetric club, with a small apical spongiose stripe,[14] the convex elytra, the longer, posteriorly

[14] According to J. Faust's certainly correct morphologic comprehension, one could better say in this case: Club (this is the tomentose terminal part of antenna) even, not projecting beyond last joint of funicle.

produced mesosternal lobe, the unarmed femora, carinate posterior tibiæ, and transverse pygidium. *Heterotoxus*, another related genus, differs by differently formed antennæ, with a large part of the club spongiose, the depressed prothorax and elytra, the small pentagonal scutellum, strongly elevated femora, etc.

Pseudacanthorrhinus bipodex sp. nov. Plate 1, figs. 10*a*, 10*b*.

Rufus, antennis, vitta mediana thoracali, scutello, vittiforme, elytris vitta suturali, altera, in primo triente abbreviata, inter striam quartam et octavam, humeris vittaque marginali conjuncta, mesosterno, coxis, genubus tarsisque (interdum macula aut vitta laterali in prothorace) nigris; rostro duabus trientibus thoracis aequali, arcuato, dorso sulco mediano; prothorace latitudine distincte longiore, haud punctato; scutello latitudine triplo longiore; elytris oblongo-ellipticis, dorso sat convexis, prothorace paulo latioribus, apice singulis subtruncato-rotundatis, punctato-striatis, spatiis, praesertim tertio quartoque, convexiusculis; pygidio transverso, apice truncato luteo-setoso, sternito anali medio profunde intruso, utrinque lo valido, luteo-setoso; femoribus apice nigricantibus, tibiis maris intus fulvo-fimbriatis. Long. 11.5 ad 13, lat. 3.5 ad 4.5 mm.

LUZON, Laguna Province, Mount Maquiling. MINDANAO, Lanao Province, Iligan (*Baker*).

A red species, easily recognizable by the pattern of elytra, with the following black markings: Prothorax with three lines, one median and one marginal on each side, sometimes reduced to a patch. Elytra with a humeral spot, and connected with this the lateral margin, then the suture, the first interval except its first third, a large vitta, abbreviate in front, between the fourth and eighth striæ, the mesosternum and all coxæ, black.

Sphenophorus nigrovittatus sp. nov. Plate 1, fig. 9.

S. alfuro Heller[15] affinis, sed aliter signatus, subsanguineus, metasterno, abdominis pars mediana antennarumque clava, nigro-denudatis; prothorace utrinque vitta, ante abbreviata, nigra; elytris singulis vitta, postrorsum attenuata, rufo-denudata, spatiis 3. ad 5. punctis pustiliformibus cinereo-tomentosis, seriatis, sutura spatioque primo vitta nigro-velutina, ante apicem abbreviata, ac in primo triente usque ad striam tertiam

[15] Ent. Mitteil. Berlin 3 (1914) 313, pl. 5, figs. 7, 7*a*.

dilatata, item altera laterali apicem versus rotundato-subdilatata. Long. 9.5, lat. 3.5 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

Differs from the nearly allied *S. alfurus* Heller, from Orani, Bataan Province, Luzon, by the black pattern of prothorax and elytra; in the former this consists of a black stripe on each side abbreviated and attenuated in front, in the latter of a broad black velvety sutural stripe, extending as far as to the second stria, dilated in the first third to the third stria, and abbreviated in the apical sixth. A similar but lateral stripe extends from the shoulder to the apical callosity. Denudate reddish discal parts of elytra with three rows of ashy tomentose punctiform pustules.

Laogenia cylindricollis sp. nov., ♂, ♀.

Niger, elytris subfuscescentibus, maris rostro dimidia parte thoracis longitudine, recto, utrinque seria remote granulata, lateribus, ut parte basali, rude punctato, feminae thoracis dimidia parte longiore, paulo arcuato, seriato-punctato; antennis funiculi articulo secundo primo aequali, reliquis crassitudine longioribus, clava conica, scapo fere longitudine aequali; prothorace, maris, latitudine fere duplo (19 : 43) longiore, feminae breviore (18 : 31), lateribus fere parallelis, in primo quarto paulo ampliatis, squamulis omnino aequaliter parumque inter se distantibus; scutello punctiforme; elytris punctato-striatis, punctis perapproximatis, squamula rotundata repletis, spatiis anguste carinatis, atomis albidis remote seriatis; pygidio remotius squamoso, dorso utrinque carina longitudinali obsoleta ac obtusa; femoribus posticis abdomen paulo superantibus, anticis prothorace aequalibus; tibiis striato-punctatis intus, praesertim anticis, serrato-denticulatis; corpore subter aequaliter sat dense, meta-episternis densissime albido-squamosis; tarsorum posticorum articulo primo secundo paulo longiore. Long. 6.5 (♀) ad 8 (♂), lat. 1.2 (♀) ad 1.5 mm. (♂).

MINDANAO, Zamboanga Province, Dapitan ♂ (*14808*), Zamboanga ♀ (*7355*).

The only hitherto described species with a similar long cylindric prothorax is *L. longicollis* Pascoe,[16] from Sumatra, but this is much smaller in size, has the prothorax longitudinally depressed, and the tibiæ fimbriate inside.

[16] Ann. Mus. Genova II 2 (1885) 305.

CRYPTODERMINÆ

Cryptoderma longicolle sp. nov., ♂.

C. collare Rits. latius ac multo maius, nigrum, cinereo-pruinosum, lineis eburneis similiter ornatum; prothorace latitudine distincte (quinta parte) longiore, lateribus in dimidia parte basali rectis, parallelis (basin versus sub-convergentibus), fortiter umbilicato-punctato, linea eburnea, mediana laterali vix tenuiore, in elytris utrinque, ante scutellum, quasi in puncto continuanda, elytris oblongo-ovatis, tuberculo subapicali nullo, rude seriato-punctatis, spatiis subconvexis, margine basali elevato, inter striam quartam et quintam exciso, inter quintum et sextum dentato-producto, linea x-forme eburnea ramis anterioribus prope ad humeros incipientibus, stria nona in duabus trientibus apicalibus eburnea; femoribus posticis tertia parte elytrorum apice extantibus. Long. 9, lat. 5.1 mm.

SIARGAO (*G. Boettcher*). A domine W. Schultze benevolenter communicatum.

Cryptoderma mangyanum [17] sp. nov., ♂. Plate 1, fig. 12.

Nigrum, umbrino-pruinosum, elytris forma earumque signatura praecedenti similibus, sed lineis eburneis multo latioribus, in stria nona nulla; antennis articulo tertio crassitudine plus duplo, septimo hac distincte longiore; prothorace longitudine latitudine aequali, lateribus fortiter rotundatis, fortiter intruso-punctato, linea eburnea, mediana, laterali tenuiore; elytris spatio secundo quartoque, praesertim post medium, subcostatis, lineis eburneis latitudine spatium unum superantibus, margine basali utrinque alte auriculato-elevato, inter striam septimam et quartam exciso, utrinque pone excisionem subangulato-producto; femoribus posticis elytrorum apice tertia parte extantibus. Long. 13, lat. 5 mm.

MINDORO, Naujan (*E. H. Taylor*).

The two species of Philippine *Cryptoderma* last described show the ordinary x-shaped ivory incrustate lines on the elytra and are related by the comparatively short-oval acuminate form of the elytra to *C. plicatipenne* and *C. brevipenne* but are larger than these; the third Philippine species (*C. philippinense* Waterhouse) belongs to the elongate subparallel species, which has a subapical callosity on the elytra.

[17] Mañgyanes is the name by which the Filipinos native to Mindoro are known.

Cryptoderma longicollis has the prothorax elongate, parallel sided in the basal half, with the ivory middle line reaching in the first interval to the base of elytra, but not touching the scutellum. Intervals of elytra slightly convex, anterior branch of the x-shaped figure connected with the lateral stripe at the level of scutellum, the ninth stria ivory incrustation in the apical half.

Cryptoderma mangyanum has a shorter prothorax with rounded sides (male) and much broader x-shaped ivory lines on the elytra, ninth stria without ivory incrustation. The vaulted and notched basal part of the male elytra is higher than in any other species, half as high (in *C. plicatipenne* Rits. one-third) as broad.

ILLUSTRATION

PLATE 1

FIG. 1. *Chirozetes lineolatus* sp. nov.
2. *Achirozetes kleinei* g. et sp. nov.
3. *Microzetes trochilus* g. et sp. nov.; *a*, funicle of antenna.
4. *Phylaitis vidua* sp. nov.
5. *Ommatolampus schultzei* sp. nov.
6. *Ommatolampus sulcirostris* sp. nov.
7. *Anathymus nigroscutellatus* sp. nov.
8. *Prodioctes surigaonis* sp. nov.
9. *Sphenophorus nigrovittatus* sp. nov.
10. *Pseudacanthorrhinus bipodex* g. et sp. nov.; *a*, funicle of antenna; *b*, last ventral sternite.
11. *Diasthetus crassiusculus* sp. nov.; *a*, funicle of antenna.
12. *Cryptoderma mangyanum* sp. nov., male.
13. *Poteriophorus regulus* sp. nov., female.

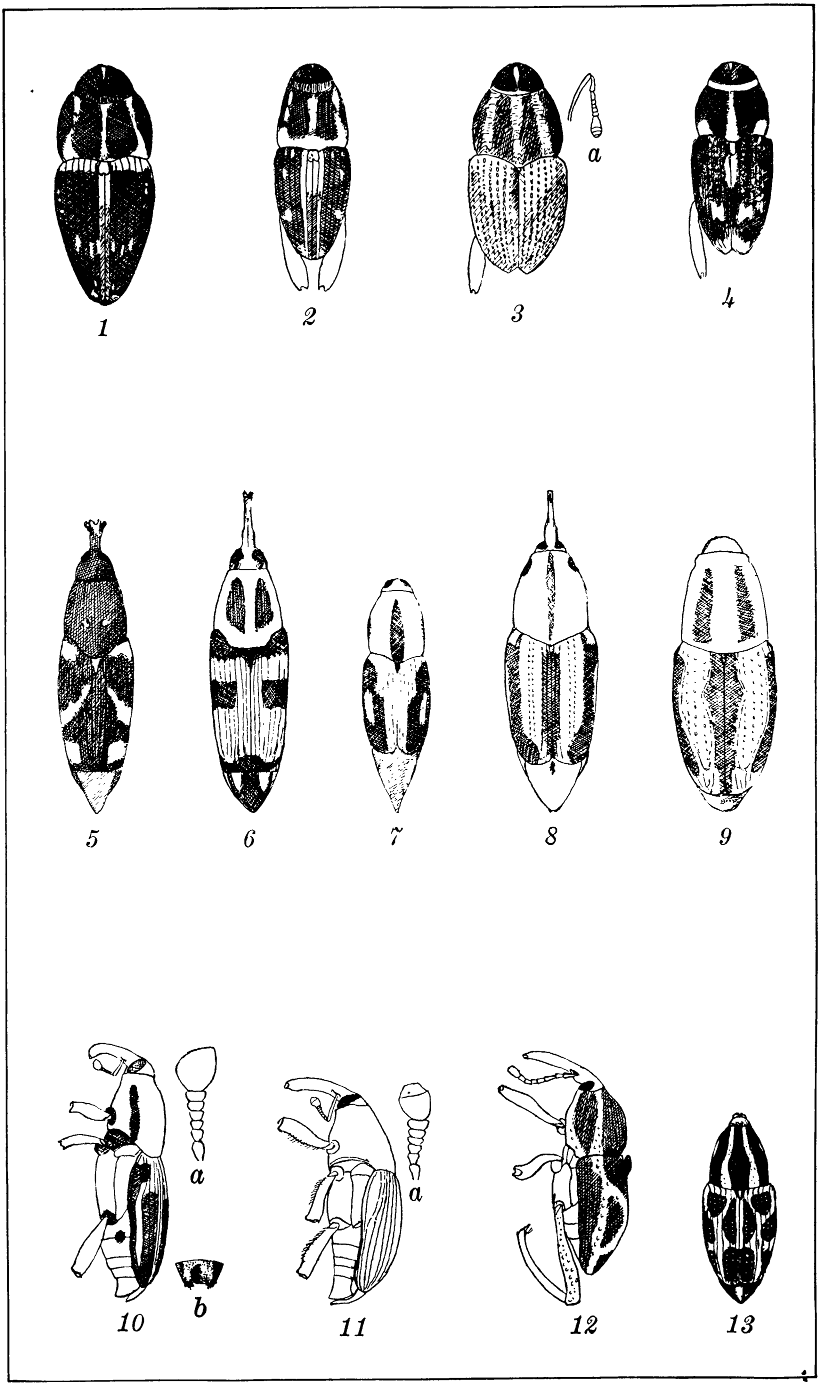


PLATE 1.

THE EFFECT OF HIGH TEMPERATURES ON THE GERMINATION AND SUBSEQUENT GROWTH OF CORN [1]

By RAYMOND KIENHOLZ

Professor of Botany, University of the Philippines, Manila

ONE PLATE AND FOUR TEXT FIGURES

INTRODUCTION

There has been a considerable increase in the use of heat in the disinfection of cereals against both insect and fungous pests, within recent years. Several publications have been issued with a view of disseminating knowledge among farmers, seedsmen, and mill owners, for the control of insects affecting stored grains and mill products. These publications are of undoubted value for that purpose, but the investigations upon which they are based too often neglect phases of the subject that are of intense interest to the plant physiologist from a scientific point of view and to the farmer and seedsman from a practical point of view. The investigators have too often been entomologists interested only in the destruction of the insect pests; or they have been heating and ventilating engineers, having the same end in view. They have paid some attention to the effect of the heat upon the edibility and the keeping qualities of the grain, but have seldom paid the amount of attention that the subject deserves to the effect of sterilizing measures on the subsequent viability of the grain. They have not worked with carefully controlled temperatures or periods of exposure, and they seldom give details as to the moisture content of the seed, the method of heating, the variety, or even the kind of seed used. Furthermore, detailed and careful experiments are seldom carried out to determine the effect of the treatment on the percentage of germination.

[1] Thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in botany in the Graduate School of the University of Illinois, 1922.

The work upon which this thesis is based was done in the laboratory of plant physiology under the direction of Prof. Charles F. Hottes, and I gratefully acknowledge his help in the selection of the problem, in its development, and in the presentation of the results.

This kind of investigation is often useless to the botanist seeking definite information; but, more important, it is sometimes positively harmful to farmers and to seedsmen who, acting on the information given, treat their seed, only to find the germination lowered or the seed killed outright. Goodwin (1922) makes this statement in an Ohio Experiment Station publication: "Corn heated to a temperature of 140° F. (60° C.) for almost two days germinated almost as well as an untreated sample from the same lot." He adds: "Of course, there is the possibility that damp seed might be injured by being raised too rapidly to such temperatures as here recorded." Although I did not heat corn at 60° C., I did get severe injury after heating corn at 70° C. for one hundred forty minutes, germination being reduced from about 98 per cent to 40 per cent. The corn I used contained about 10.5 per cent moisture, which is lower than the moisture content of most air-dry corn. Similarly, De Ong (1919) working with various seeds, including corn, gives heat treatments of 100° to 158° F. for five hours, 124° to 154° F. for two hours, and 125° F. for eight hours and gets average germination percentages of 86, 88, and 94, respectively. He says the effect on grains is so small as to be almost negligible. Corn is included among the grains, though it is much more sensitive to heat than wheat or barley, and would be injured by heat that would not affect these grains.

The artificial drying of cereals or of other seeds to prevent loss in storage should likewise be carried on under carefully controlled conditions and at temperatures known to be low enough not to injure the viability of the seed at a given moisture content. This is important in the drying of corn which is to be used for seed, especially during seasons when frost necessitates an early harvesting of the crop, while it is full of moisture and liable to "heat" in storage. Insufficient data are available on the moisture–temperature relations of most of our cereal seeds, and one of the purposes of this investigation was to determine the temperature relations of corn with a known amount of moisture.

With the failure to control certain seed-borne diseases by means of chemical disinfectants has come the attempt to control them, first by hot-water treatments, then by dry-heat treatments, and finally by soaking treatments followed by heat treatment. Here again insufficient attention has been paid to the effect of these treatments on the germination and, above all, on the subsequent growth and yield of plants from treated seed as com-

pared with the growth and yield of plants from untreated seed. Many seed-borne diseases, especially those in which the fungus is within the seed itself, are being studied and an attempt is being made to control them by dry heat. Atanasoff and Johnson (1920) have reviewed the earlier work on the use of dry heat in the control of disease, preparatory to a discussion of their own results on the control of various cereal diseases borne on the seeds of wheat, barley, rye, and oats. They heated these seeds in a gas or electric oven at 100° C. for fifteen and for thirty hours. They state that the germination, in sand, was lowered slightly, compared with untreated checks, and that the plants from treated seed were slow to start but soon caught up with their checks and remained normal. They make no mention of the kind of container in which the seed was heated, whether the seed was spread out in a thin layer or heaped together in a small container, nor do they mention moisture content beyond saying, "good dry seed of barley, wheat, oats and rye is able to withstand suprisingly well the high temperature used, up to thirty hours." These results should by no means be interpreted as being applicable to corn and, before this method of seed treatment is broadcasted among farmers or seedsmen, additional work should be done to determine what is meant by "good dry seed" and how frequently it exists in the farmer's bins under ordinary storage conditions. Dickson (1920), working at the same station as Atanasoff and Johnson (1920), later recommends three hours' exposure to 100° C. as a control measure against wheat scab and against seedling blight of wheat, but says nothing further concerning methods. Walker (1922) has attempted to control cabbage black-leg by means of dry-heat treatment of the seed. He has made moisture determinations of the seed treated.

With the increasing importance of root and stalk rots of corn in the United States comes the attempt to control or to lessen their damage. Soil treatments have proved unreliable, and seed treatments have proved unsatisfactory, although Branstetter (1922) reports a lessening in the number of diseased plants from seed treated by immersion in alcohol and mercuric chloride, as compared with untreated checks. The possibility of heat treatment presents itself, but before this is attempted we should know something of the moisture–temperature relations of the corn to be treated.

The facts to be established in this investigation were: (*a*) the time–temperature relations of corn with known amounts of

moisture, but especially in the air-dry condition; (*b*) the effect of desiccation on viability and resistance to heat; and (*c*) the effect of heat treatment of the seed on the subsequent growth of the seedling.

Three types of corn, varying in amount of infection and susceptibility to disease under field conditions, and varying in physical composition, were used in determining these facts. Any variations in response to the conditions imposed by the experiment were noted, in the hope of explaining them by means of the differing characteristics of the kinds of corn used and thus determining the characteristics that govern the behavior of corn in response to various factors, such as temperature and humidity.

MATERIALS

The three types of corn used in this investigation varied as to their physical characters, vitality, and degree of infection with various root-rot fungi. All three types were of the Reid's Yellow Dent variety, were from the 1920 harvest, and were furnished by Mr. J. R. Holbert, of Bloomington, Illinois. According to results obtained on the germinator, Mr. Holbert classified them as: (*a*) apparently diseased; (*b*) original composite (badly diseased); and (*c*) apparently disease-free. Throughout this investigation these types of corn will be known as: (*a*) Diseased, (*b*) Badly diseased, and (*c*) Disease-free. Each of these three types he further classified according to physical characters, vitality, and degree of infection.

The physical characters of these types of corn are of interest because of the correlation known to exist between them and resistance or susceptibility to root rots. They are classified as to physical composition of kernels, indentation of kernels, brightness of shanks, brightness of kernels, development of kernels, tip covering of ears, and luster of ears; of these, physical composition, indentation, brightness of kernels, and development of kernels come under direct consideration in this investigation. These characters, expressed in percentages, are summarized in Table 1.

From Table 1 it is noted that Disease-free corn possesses, to a high degree, many of the physical characters correlated with slightly infected, resistant corn. Thus, it has a high percentage of horny, smooth, bright, plump kernels; good luster of ears; and ears with tips covered. Diseased corn has a few of the characters correlated with infected, susceptible corn, such as dull,

TABLE 1.—*Physical characters of the three types of corn used.*

[Numbers give percentages.]

Type of corn.	Physical composition of kernels.			Indentation of kernels.			Brightness of shanks.			Brightness of kernels.			Development of kernels.			Tip covering of ears.			Luster of ears.		
	Horny.	Medium.	Starchy.	Smooth.	Medium.	Rough.	Bright.	Medium.	Discolored.	Bright.	Medium.	Dull.	Plump.	Medium.	Shriveled.	Covered.	Medium.	Exposed.	Good.	Medium.	Dull.
Diseased	15.5	59.3	*25.2*	14.3	33.6	52.1	2.5	49.2	48.3	42.4	35.3	*22.3*	2.1	68.5	*29.4*	24.8	35.7	39.5	10.9	67.2	*21.9*
Original composite (badly diseased)	7.2	*79.4*	13.4	3.1	24.7	*72.2*	7.2	42.3	50.5	41.2	*38.2*	20.6	28.8	67.0	4.1	17.5	37.1	*45.4*	5.2	*85.5*	9.3
Apparently disease-free	*70.4*	28.4	1.2	*62.5*	*36.4*	1.1	*22.7*	*69.3*	8.0	*82.9*	14.8	2.3	*30.7*	*69.3*	-----	*27.3*	*62.5*	10.2	*28.4*	64.8	6.8

shriveled kernels and dull luster of ears. More important, however, is its large percentage of starchy kernels. My results indicate that this character is correlated with its ability to take up and give off moisture, and largely determines its subsequent behavior. Badly diseased, on the other hand, has many of the characters common to badly diseased corn, such as a high percentage of rough, medium bright and medium starchy kernels, and medium luster of ears. Its high percentage of medium starchy kernels probably accounts for its behavior in regard to moisture content.

After germinating thirty kernels from each ear and noting the percentage of germination and the degree and kind of infection on the germinator, Mr. Holbert classified each of the types according to vitality and degree of infection.

TABLE 2.—*Vitality and degree of infection.*

[Numbers give percentages.]

Type of corn.	Vitality.	Degree of infection.	
		Fusarium.	*Diplodia.*
Diseased	99.48	3.45	
Badly diseased	96.5	12.7	1.5
Disease-free	99.4	0.9	

The relative susceptibility to disease under field conditions, as indicated by the names of the three types of corn, has little effect on their viability. Mr. Holbert's tests show Diseased to have a slightly higher percentage of germination than Diesase-free, while my tests (Diseased, 96.8 per cent; Badly diseased, 93.2 per cent; Disease-free, 97.4 per cent) on the corn as it was used are slightly different.

Tables 1 and 2 have been constructed from unpublished data kindly furnished by Mr. Holbert, to whom thanks are due.

The corn was received at the laboratory on the ear and was stored in a dry place in large, covered, tin boxes. In the early work individual ears of each type were used as the source of the corn tested, the number of the ear was recorded, and all of the good kernels from the ear, except those at the extreme tip and butt, were used. It was soon noticed that individual ears varied widely in their resistance to heat, their vigor of germination, and their degree of infection. In order to arrive at the extent of this variation, six ears of each type were taken

at random and tested at 80° C. and 90° C.; the results of these tests are summarized in Table 3.

TABLE 3.—*Summary of the individual variation of the ears.*

[Numbers give percentages of germination.]

Diseased.				Badly diseased.				Disease-free.					
									First trial.		Second trial.		
Ear No.	80°C.	90°C.	Average.	Ear No.	80°C.	90°C.	Average.	Ear No.	80°C.	90°C.	80°C.	90°C.	Average.
70	66.6	50.0	58.3	12	57.5	32.0	44.8	17	30.0	50.0	16.7	40.0	34.2
72	86.7	47.5	67.1	2[illegible]	62.5	12.0	37.3	18	40.0	50.0	20.0	33.3	35.8
116	80.0	50.0	65.0	37	62.5	36.0	49.3	33	*57.5*	*57.5*	*43.3*	*40.0*	*49.6*
137	86.7	47.5	67.1	38	55.0	36.0	45.5	54	37.5	57.5	23.3	43.3	40.4
166	*91.7*	50.0	*70.9*	55	55.0	40.0	47.5	80	55.0	52.5	43.3	43.3	48.5
176	76.6	*60.0*	68.3	75	*67.5*	*40.0*	*53.8*	93	*35.0*	*37.5*	*20.0*	*30.0*	*30.5*

Some ears did not vary widely from the average, or were not consistent in their variation; while others, notably, Badly diseased No. 75 and Disease-free No. 33, were consistently high in percentage of germination, and still others, as Disease-free No. 93, were low in percentage of germination.

The corn kernels often had their coats broken; this was especially true of the rougher ears such as those of Badly diseased, where the shriveled, attenuated crown, which caused the roughness of the ears, is very easily broken. Such kernels were discarded, as were also those injured by the grain moth. Some kernels had their tips broken off, exposing the black cap that covers the lower part of the embryo. To determine whether these kernels were more readily injured by heat than were those with the tips intact tests were made, using the three types of corn. The tips were in most cases broken off artificially, but differed in no way from those whose tips were broken off in the shelling process.

Kernels with tips broken off gave 39.3 per cent germination, while kernels with tips intact gave 44.7 per cent germination, a difference of 5.4 per cent. There was practically no difference in length of plumule. Each type responded similarly to this treatment. No tests were made of kernels with broken crowns, though results would probably have been less significant than those given. The difference noted justified me in selecting only kernels with tips and crowns intact.

Because of the variation between individual ears, most of the investigation was carried on with composite samples obtained

by selecting the same number of good kernels from each ear and mixing them thoroughly. This composite was kept in tin cans in the laboratory.

These investigations involved the use of 30,000 kernels, tested in lots of 10 and 25, unless otherwise indicated.

METHODS

The apparatus used in the heating of the seeds was similar to that used and described by Groves.[2] It consisted of a copper bath 15.5 centimeters high and 21 centimeters in diameter, with a capacity of about 4 liters (Plate, 1 fig. 4). The top was perforated by ten tubulatures (3 centimeters in diameter) around the periphery and one in the middle. The baths were placed on electric hot plates. They were exactly the size of the hot plate, and a galvanized-iron sleeve was fitted around the base of the bath, extending down over the hot plate, thus preventing rapid radiation of heat and at the same time holding the bath in place. In the center tubulature of each boiler a double bulb reflux condenser made of block tin was tightly fitted. The temperature of the bath was measured by a standard, Government-tested, Centigrade thermometer which could be slipped in and out of a glass tube leading down into one of the glass phials described below. A thermometer with its phial was fitted into one tubulature in each boiler. These phials contained corn to keep the bulb of the thermometer from having contact with the glass. This left nine tubulatures which could be used for the heating of the corn.

The glass phials were 9 by 2 centimeters and were fitted with rubber stoppers through which extended 15-centimeter capillary tubes of 1-millimeter bore. These capillary tubes were used to allow for the expansion of the air on heating and thus to hasten a rapid adjustment of temperature.

A larger rubber stopper at the upper end of this capillary tube fitted the tubulatures in the copper bath and supported the phial in the liquid (Plate 1, fig. 4). By adjusting the distance between the two stoppers the phials were in all cases completely submerged, in order to make the temperature of the phials uniform throughout and also to make visible any leakage that might occur around the stoppers. If any leakage did occur the test was discarded. When not in use the tubulatures in the boiler were kept tightly closed with corks, in order to reduce to a minimum the loss from evaporation and the consequent change

[2] Trans. Illinois Acad. Sci. 8 (1915) 133–136.

in the boiling point of the fluid. Several tests were made to determine whether a difference in the size of the opening in the glass tubing resulted in a difference in the percentage of germination. A series of tests, using the capillary glass tubing with 1-millimeter inside diameter was contrasted with one using ordinary glass tubing with 4-millimeter inside diameter. The average percentages of germination of three trials at 80° C. and at 90° C. were 10.6 and 0.3 in favor of the ordinary glass tubes, and 4 in favor of the capillary tubes. The plumule lengths varied slightly in the same way. These results would indicate that this slight difference in size of the opening has little, if any, effect on the resistance to heat of the treated corn.

To obtain the desired temperatures, advantage was taken of the different boiling points of various liquids and of various mixtures. Thus, to secure a temperature of 100° C. a mixture of glycerine and water was used in the proportion of 13 to 87. This mixture boiled at exactly 100° C. and the condenser refluxed the liquid back into the boiler, thus maintaining a uniform boiling point. To secure temperatures of 90° C. and 80° C. mixtures of ethyl alcohol and water were used, while to secure a temperature of 70° C. a mixture of methyl alcohol and water was used. The exact proportions of the mixtures used are summarized in Table 4.

TABLE 4.—*Proportions of various liquids used in obtaining temperatures from 70° C. to 100° C.*

Temperature.	Distilled water.	Other fluids.	
°*C.*	*Per cent.*		*Per cent.*
100	87	Glycerine	13
90	75	Ethyl alcohol	25
80	38	do	62
70	15	Methyl alcohol	85

Distilled water was used in each case with commercial alcohols or with glycerine. Care was taken to adjust the boiling point of the mixture before each trial and the variation in temperature was kept within 0.5° C.

The phials were kept dry and clean inside and were warmed before loading, to hasten the change in temperature to that of the bath. With the high temperatures and the short periods of heating this became an important factor. The slow rise in temperature of the phials and their contents makes it difficult to determine the temperature to which the corn was actually

exposed. This difficulty, however, has been experienced by every investigator of temperature in its effect on seeds. The method of heating was uniform for each type of corn and should have introduced no error here. In an effort to determine the speed of the temperature rise, phials fitted with thermometers were inserted in the bath, and the time required to reach certain temperatures was noted. At first the rise was very rapid; but gradually it decreased in rapidity until it was difficult to determine the rate, so slowly did it rise. An average of about fifteen minutes was required for empty phials to change from 28° to 99.5° C. Starting at 28° C., 40° C. was reached in twenty-four seconds; 90° C. was reached in four minutes; 99.5° C. was reached in fourteen minutes and thirty seconds. When the phials were loaded the rise in temperature was slightly slower than in the case of empty phials.

After the corn had been heated the phials were removed from the bath, and the corn was immediately placed in small aluminum dishes to cool. It was then placed in rag dolls to germinate. The rag dolls used were made of a good grade of bleached muslin, 8.75 by 48 inches (about 23 by 122 centimeters). Six lots of ten seeds each were placed in one rag doll, thus giving ample room for germination and growth.

The dolls were thoroughly washed, scrubbed, and boiled before using, thus insuring a certain amount of freedom from saprophytic fungi. The modified rag doll as described by Duddleston (1920) was used only where the relative degree of infection was sought. The ordinary unwrapped method proved adequate to show germination vigor and was much quicker and cheaper than the modified method. The dolls were placed in lukewarm water and allowed to soak for ten hours. They were then removed and allowed to drain thoroughly and placed in gallon jars provided with drainage, and other jars were placed over them (Plate 1, fig. 1). This method proved satisfactory and convenient. These germinators were placed in a temperature case with the temperature accurately regulated at 30° C. Haberlandt (1874) gives the optimum temperature for the germination of corn as 34° C., and Lehenbauer (1914) says the optimum temperature for the growth of maize seedlings is between 29° and 32° C. The advantages of the constant temperature and the fact that the temperature cases were a permanent part of the laboratory's equipment outweighed the disadvantage of building apparatus to make pos-

sible a slight rise in temperature to the reported optimum. After five days (including the soaking period) at 30° C. the rag dolls were opened and read for amount of germination and length of plumule (Plate 1, fig. 3).

It is realized that the rag doll is not an ideal method of germinating corn, but it is the quickest, best method of handling a large number of germinating kernels in a way that would make the results comparable to those obtained by the farmer in testing his corn. Every method has its disadvantages, but those of the rag doll seemed least, because it is readily available, compact, quickly and easily handled, and tends to familiarize one with a widely used method. It was noticed that the outside of the rag doll gave slightly poorer germination than the inside, and that the lower part of the rag doll gave poorer germination than the upper part.

The wire cores (Plate 1, fig. 3) on which the rag dolls were rolled probably gave as great aëration to the inside of the dolls as the outside. This, coupled with better moisture conditions, gave better germination on the inside than on the outside. Too much moisture caused a poorer germination in the lower part of the rag doll than in the upper part. These variations, however, acted equally upon all three types and did not introduce an error in the results.

Waggoner (1917) has clearly shown one of the reasons for the discrepancies in the results obtained by earlier investigators on the effect of high temperature on seeds; namely, the method used in heating. In his own work he has shown the decided difference in the effect of heat on viability when the seeds were heated in an open oven and when heated in flasks. In order to determine whether this difference held also for the types of corn under investigation, air-dry corn was heated at 70° C. for 100, 120, 140, and 160 minutes in phials as already described and also in large test tubes, 26 millimeters in diameter and 150 millimeters long. These test tubes were given several turns of electricians' friction tape around the top so as to make them fit the tubulatures in the bath tightly, and more tape was used to seal the tubes into the tubulature so as to prevent the escape of steam. These test tubes quickly reached the same temperature as the bath, and the corn to be treated was placed in small wire baskets and lowered into the tubes. The corn was thus in a dry heat equal to the heat applied to the phials and was treated the same length of time in each case. In the

one case there was much space for the moisture to escape from the kernels while in the case of the phials fitted with capillary tubes a very limited amount of moisture could escape.

Table 5 gives the significant results of a test conducted with air-dry corn at 70° C.

TABLE 5.—*Heating air-dry corn in open test tubes compared with heating in phials, at 70° C.*

[T, open test tubes; P, phials.]

PERCENTAGE OF GERMINATION.

Type of corn.	Minutes heated.								Average.	
	100		120		140		160			
	T	P	T	P	T	P	T	P	T	P
Diseased	90	80	100	30	90	70	100	30	*95.0*	*52.5*
Badly diseased	100	40	80	50	60	20	60	12	*75.0*	*30.5*
Disease-free	100	70	100	50	100	10	100	20	*100.0*	*37.5*
Average									*90.0*	*40.2*

LENGTH OF PLUMULE IN MILLIMETERS.

Type of corn.	100 T	100 P	120 T	120 P	140 T	140 P	160 T	160 P	Average T	Average P
Diseased	113	49	100	51	80	19	91	7	*96.0*	*31.5*
Badly diseased	71	7	76	15	29	10	42	8	*54.5*	*10.0*
Disease-free	118	49	98	12	81	13	91	13	*97.0*	*21.8*
Average									*82.5*	*20.8*

Waggoner (1917) states that the chief factor determining the resistance of seeds heated to the same temperature by different methods is the amount of moisture absorbed or lost during the treatment. On this basis the results given in Table 5 are undoubtedly more significant than they would be at a higher temperature, because a long heating period allows much moisture to escape before injury or killing takes place. At high temperatures and short heating periods it is doubtful if any such difference would be noted. The average difference of 49.8 per cent in germination and 61.7 millimeters in length of plumule, and the consistently lower percentage of germination and length of plumule of those kernels heated in phials, at all temperatures used, show conclusively that less heat was required for injury or death when the corn was heated in closed phials than when the corn was heated in open test tubes.

After it was heated the corn was immediately placed in aluminum dishes to cool. This was done in order to cool the corn as rapidly as possible after its period of heating was over. To determine if this method was the best one to follow, air-dry

corn was heated to 90 °C. for from four to seven minutes, one series being allowed to remain in the corked phials to cool, and the other being placed in the aluminum dishes to cool. The percentage of germination of that cooled in the phials was 60.8, while that cooled in the dishes gave 65 per cent germination, a difference of 4.2 per cent. Similarly the difference in plumule lengths was 23.3 millimeters in favor of the corn cooled in the aluminum dishes.

A method was devised whereby the corn could be quickly loaded into the phials which were already in place and heated to the desired temperature, but the results from this method did not differ from those obtained by loading the phials and then inserting them into the bath; hence this method was not used.

RESULTS AND DISCUSSION

EFFECT OF HEAT ON AIR-DRY CORN

No extensive work has been done on the time and the temperature required to injure or to kill corn by subjecting the kernels to heat. Almost without exception, where time and temperature are given, no mention is made of the moisture content of the corn, though it has been known for many years that the drier the seeds are the greater the degree of heat that they can withstand. Miss White (1909), in her studies on ferments in seeds, heated corn at 99° to 100° C. for six and one-half hours and got no germination, while corn heated for one hour at 122° and 124° C. was also killed. Burgess (1919), in investigating possible injury done to the vitality of seeds by heat treatment for insect pests, found that corn gave 68 per cent germination when treated at 176° F. (80° C.) for one hour, and 32 per cent when treated for three hours. Montgomery (1917), investigating a similar problem, said that "the germinating quality of grain is destroyed at 150° F. (65.6° C.) and probably injured at 5° less (62.8° C.), if long exposed." Ear corn hanging in a seed room which was disinfected several times at 140° F. (60° C.) for several hours at a time, was apparently not injured.

All of the work that has been done, and it is small in amount, is of the same fragmentary nature as that reported above. Thus it seemed the first task to find out the exact time and temperature relations of air-dry corn under the conditions of the experiment; namely, dry heat applied to corn in phials fitted with capillary tubes, the volume of the phial being about eight times that of the kernels being tested.

It should be borne in mind that the moisture content averages of air-dry corn, as kept in the laboratory, were as follows: Diseased corn, 10.93 per cent; Badly diseased corn, 10.64 per cent; Disease-free corn, 10.41 per cent. These percentages are based on the air-dry weight of the seed and were determined as described below. It is to corn of the above-stated moisture content, that the time and temperature figures given in Tables 6, 7, 8, and 9 apply. Although the moisture content of the corn varied somewhat, it was less than if it had been stored outdoors, subject to varying climatic conditions.

The averages of many moisture determinations made on samples from all over the State of Illinois, by the division of crop production, College of Agriculture, University of Illinois, are as follows: For samples received and tested in February, 15 per cent; March, 13 per cent; April, 12 per cent. These figures should not be lost sight of in the drying of corn or in heat treatments for insect or fungous pests.

TABLE 6.—*Air-dry corn heated at 100° C. in an oven.*

PERCENTAGE OF GERMINATION.

Type of corn.	Minutes heated.					Average.
	5	7.5	10	12.5	15	
Diseased, 184[a]	100	24	44	0	0	33.6
Badly diseased, 71	88	56	0	8	0	30.4
Disease-free, 77	92	72	32	4	0	40.0
LENGTH OF PLUMULE IN MILLIMETERS.						
Diseased, 184	108	19	11	0	0	27.6
Badly diseased, 71	102	71	0	7	0	36.0
Disease-free, 77	152	112	14	4	0	56.4

[a] Refers to number of ear used.

The corn heated at 100° C. (Table 6), was heated in an electric oven in open aluminum dishes. This accounts for its not being killed until after fifteen minutes exposure, while the same kind of corn was killed in nine minutes at 90° C. when heated in phials. This illustrates again the difference due to the method of heating. At 100° C. the period required to kill, when the phials were used, was so short that it was difficult to get results of much comparative value, because of the slow rise in temperature in the phials and the resulting uncertainty as to just what temperature was reached in the phials during the shorter periods of heating. Only a few minutes were re-

quired to kill when 100° C. was used, and the actual temperature to which the corn was subjected at the end of this time was undoubtedly below 100° C.

TABLE 7.—*Air-dry corn heated at 90° C. in phials.*

PERCENTAGE OF GERMINATION.

Type of corn.	Check.	Minutes heated.							Average.
		3	4	5	6	7	8	9	
Diseased	100	100	90	90	30	70	10	0	55.7
Badly diseased	100	90	100	90	80	70	0	0	61.4
Disease-free	100	100	100	80	60	70	20	0	61.4
LENGTH OF PLUMULE IN MILLIMETERS.									
Diseased	132	118	114	98	58	103	5	0	70.9
Badly diseased	107	119	94	101	96	52	0	0	66.0
Disease-free	135	126	122	98	68	89	51	0	79.1

TABLE 8.—*Air-dry corn heated at 80° C. in phials.*

PERCENTAGE OF GERMINATION.

Type of corn.	Check.	Minutes heated.					Average.
		10	12.5	15	17.5	20	
Diseased	80	96.7	70	40	10	0	43.3
Badly diseased	100	90.0	60	40	0	0	38.0
Disease free	100	93.3	70	53.3	0	10	45.3
LENGTH OF PLUMULE IN MILLIMETERS.							
Diseased	151	132.3	73	20.7	5	0	46.2
Badly diseased	169	110	77	32.3	0	0	43.9
Disease free	172	127	90	26.6	0	5	49.7

TABLE 9.—*Air-dry corn heated at 70° C. in phials.*

PERCENTAGE OF GERMINATION.

Type of corn.	Minutes heated.					Average.
	60	80	100	120	140	
Diseased	90	90	80	40	50	70.0
Badly diseased	90	70	60	60	50	66.0
Disease free	100	80	50	20	20	54.0
LENGTH OF PLUMULE IN MILLIMETERS.						
Diseased	114	110	79	39	40	76.4
Badly diseased	126	88	64	13	8	59.8
Disease free	135	78	71	49	54	77.4

When 90° C. was used and the corn treated in phials complete killing took place at nine and ten minutes, while injury to germination was manifest at five minutes. A slight decrease in plumule length, already noticeable at three minutes when compared with the check, may be due to retardation of germination and growth caused by heating, or it may be due to actual heat injury. It is possible that the corn heated for three minutes would finally overcome the retardation of its growth, and give as great a growth as the check. No studies were made on this point, but it was noticeable throughout the entire investigation (see Tables 6, 7, 8, and 9), that the length of plumule at the end of five days is much less in those seeds heated for a longer period than in those not heated so long. Much of this is due, I am convinced, to actual injury done by the heat, which the plant can never overcome. In any case, the effects of heat are more quickly noticeable in length of plumule than in percentage of germination. Care must be taken, however, to draw conclusions only from considerable numbers because of the greater variation in plumule length, as compared with percentage of germination.

Air-dry corn heated at 80° C. in phials, is practically all killed after twenty minutes and is all killed after twenty-five minutes exposure. Injury is already noticeable after ten minutes exposure.

Limited data do not allow me to give the exact length of time required to kill at 70° C., though injury is apparent after eight minutes exposure. A series which was made unusable by being read too early indicates that after longer periods of exposure (160 and 180 minutes) the Badly diseased corn and the Disease-free corn are almost completely killed while the Diseased corn germinates 50 and 30 per cent. The whole series averages as follows: Diseased, 55 per cent; Badly diseased, 28.3 per cent; Disease-free, 26.7 per cent; with the plumule lengths in a similar ratio. This behavior is similar to that experienced in the heating of desiccated corn, discussed below. It further resembles the results obtained on heating desiccated corn, in that the differences in resistance are most noticeable at lengths of exposure which are highly injurious. This is borne out by the results given in Table 9 where the resistance to heat is exactly opposite to that recorded in Tables 6, 7, and 8.

This interesting and significant relationship between the different types of corn and their varying resistance to heating at low and at high temperatures is shown in Table 10. This may

be due to the greater amount of water given off by Diseased corn during the long heating process, at a comparatively low temperature, than by the other two types of corn and the consequent greater resistance to heat.

TABLE 10.—*Summary of results obtained by heating corn at a low temperature (70° C.) compared with results obtained by heating at high temperatures (80° C. to 100° C.).*

[Numbers give germination percentage.]

Temperature.	Diseased.	Badly diseased.	Disease-free.
°C.			
70	70.0	66.0	54.0
Average of 80, 90, and 100	30.9	43.3	48.9

The average of results for 80°, 90°, and 100° C. given above, together with the results of moisture determinations given in Table 14, justifies the statement that air-dry Diseased corn contains the most moisture and is least resistant to heat, Disease-free corn contains the least moisture and is most resistant to heat, while Badly diseased corn is intermediate in both moisture content and resistance to heat.

DESICCATION

From the time of the earliest investigations to the present increasing importance has been ascribed to the moisture content of grains as affected by high temperature. As a result, in most recent articles, with some notable exceptions, dealing with the effect of heat on viability the authors are careful to state fully the conditions of the experiment, the seed used, the method of heating, and the moisture content of the seed. Waggoner (1917) has summarized the earlier work on the relation of moisture content to viability of seed heated to different degrees, and his own work is the first detailed quantitative piece of work, using one kind of seed. He has shown that the resistance of seeds of radish, exposed to high temperatures, is inversely proportional to their initial water content at the time of heating.

The purpose of this part of the investigation, then, was to determine to what extent this was true of corn, to ascertain the actual time and temperature relations of corn desiccated for various periods of time as compared with air-dry corn, and to determine if the three types of corn used responded similarly to this treatment.

Two-quart Mason fruit jars were fitted with rubbers and tightly fitting screw covers. Hooks were soldered into the

middle of these covers, from which hung paraffined wire baskets filled with corn (Plate 1, fig. 2). About 150 cubic centimeters of concentrated sulphuric acid (specific gravity, 1.84) were placed in the bottom of each jar as the desiccating agent. The moisture content of each of the three types of corn was thus gradually lowered and at intervals corn from the baskets was tested to determine its resistance to heat. Care was taken to prevent inequality in the rate of desiccation by having the top of the column of corn the same distance from the surface of the acid, in each type of corn. Sets of these jars were started at intervals in order to have a succession of corn of different moisture contents for a series of trials. The jars were placed in a 30° C. constant temperature case and were removed only while being tested. As the length of time of desiccation increased, the temperature used was increased and the time of exposure lengthened. The results of trials at various times and temperatures, after desiccation of 1, 2, 4, 6, 8, 9, 10, 12, 14, 15, 17, 20, 23, 27, 31, and 100 days are given in Table 11. The results are expressed as percentages of germination and these are averaged at the foot of the table. Those treated at 80° C. are grouped in the lower left hand corner of the table, those at 100° C. in the upper right-hand corner, and those at 90° C. in the middle of the table; and each set of results is divided from the others by a heavy zigzag line. Thus, the three types of corn which had been desiccated for 8 days were treated at 90° C. for 35, 40, 45, and 50 minutes and also at 80° C. for 100, 110, 120, and 130 minutes, and the percentage of germination for each is given in its proper place.

Difficulty was encountered in determining the proper time and temperature to use in testing the corn. As desiccation steadily decreased the moisture content, the time and temperature of treatment had to be increased in order to be injurious enough to give significant results. At the beginning of the desiccation period and with the lower temperature the change in time was rapid, while toward the end of the desiccation period and with the higher temperatures the change was slow. As a result of this constantly changing resistance of the corn to heat, much of my early work was of little value, except to indicate the proper time and temperature to use for corn desiccated a certain length of time. Hence the need for a succession of desiccations in order to get significant results.

It is evident from Table 11 that corn desiccated 2 days, containing 8.78 per cent moisture and killed when exposed for 20

TABLE 11.—*Percentage of germination of corn desiccated for different lengths of time over sulphuric acid.*

Time of Heating in minutes	1 Day			2 Days			4 Days			6 Days		
	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free
5				90	90	100						
7½				50	90	90						
10				50	100	60	100	90	90			
12½	100	80	80									
15	100	90	80	20	20	10	90	70	70			
17½	90	80	80									
20	80	50	70	0	0	0	70	30	40			
22½												
25							65	30	10	70	10	20
30							50	0	0	70	40	40
35										60	20	30
40										80	0	10
45												
50												
55												
60												
65												
70							100	80	80			
75							100	80	90	100	90	100
80							100	80	90	50	70	80
85							100	90	80	100	70	80
90										90	70	80
100												
110												
115												
120												
125												
130												
135												
145												
150												
155												
160												
165												
180												
195												
210												
225												
Average	92.5	75.0	79.5	42.0	60.0	52.0	86.1	61.1	61.1	77.5	46.3	55.0

Time of Heating in minutes	8 Days			9 Days			10 Days			12 Days		
	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free
5										100	80	100
7½												
10										80	50	50
12½												
15										40	0	10
17½												
20										0	10	0
22½												
25				80	60	70	90	60	90	0	0	0
30				100	50	70	80	50	80			
35	90	40	90	60	60	60	90	60	80			
40	90	70	80	90	30	40	100	50	60			
45	90	-	80							90	90	90
50	50	40	20							90	50	80
55												
60										70	30	50
65										90	30	20
70										60	30	20
75										50	20	50
80												
85												
90												
100	90	70	95									
110	100	80	100									
115												
120	90	40	90	100	80	100						
125												
130	90	60	80									
135												
145												
150				90	60	80						
155												
160												
165												
180												
195												
210												
225												
Average	86.3	57.1	79.4	86.6	56.6	70.0	90.0	55.0	72.5	60.9	35.5	42.7

Time of Heating in minutes	14 Days			15 Days			17 Days			20 Days		
	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free
5												
7½												
10												
12½												
15	40	0	20				60	20	30			
17½												
20	10	0	10				20	0	10			
22½												
25	0	0	10				30	0	0			
30	0	0	0				0	0	0			
35												
40												
45												
50												
55	90	60	70									
60	80	30	50									
65	80	60	70									
70	65	30	30							100	60	70
75	80	60	80							90	70	100
80	50	10	40							80	80	50
85										80	60	70
90	20	40	40									
100	70	0	50									
110	50	20	20	80	0	10						
115												
120	20	10	20	70	0	0						
125												
130				50	0	0						
135												
145												
150												
155												
160												
165							60	10	10			
180							90	10	10			
195							10	0	0			
210							70	0	0			
225												
Average	46.8	22.9	36.4	66.7	0	3.3	42.5	5.0	7.5	87.5	67.5	72.5

Time of Heating in minutes	23 Days			27 Days			31 Days			100 Days		
	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free	Diseased	Badly Diseased	Disease-free
5												
7½												
10												
12½												
15	90	70	90									
17½												
20	80	40	40									
22½												
25	90	10	20									
30	40	10	10	40	30	50	80	30	60			
35	70	10	0	80	10	30	70	40	90			
40				80	10	10	86	0	50			
45				40	0	0	-	-	39			
50				40	0	0						
55				50	0	30						
60				60	0	0						
65												
70												
75												
80												
85												
90										40	-	60
100												
110												
115												
120										80	70	40
125				70	40	70						
130												
135				90	60	60						
145				80	60	60						
150										70	90	30
155				80	60	70						
160												
165												
180	70	60	0									
195	70	40	40									
210	80	50	30									
225	100	60	30									
Average	76.7	38.9	28.9	64.5	24.5	34.5	78.7	23.3	59.8	63.3	80.0	43.3

80° C. 90° C. 100° C.

minutes, at 90° C. is very much less resistant to heat than corn desiccated 23 days, containing 5.75 per cent moisture and giving a germination of 63.3 per cent after exposure to 90° C. for 225 minutes. Similarly, corn dessicated 14 days, containing 6.11 per cent moisture and killed when exposed for 30 minutes at 100° C., is much less resistant than corn, desiccated 100 days, containing 2.15 per cent moisture and giving 63.3 per cent germination after exposure to 100° C. for 150 minutes. This relation existing throughout the table justifies the statement that, without regard to the type of corn used, the resistance of corn to heat varies inversely to its moisture content at the time of heating.

Probably the most significant fact brought to light by the desiccation study is the varied response of the different types of corn to the treatment. Beginning with the first day of desiccation and continuing throughout the experiment (100 days), the percentage of germination of Diseased after heating is much higher than either Badly diseased or Disease-free, while Badly diseased is somewhat lower than Disease-free, which occupies an intermediate position throughout. The averages of Table 11 are brought together in Table 12 and make these differences more evident.

Using the percentage of germination of Disease-free corn as zero, the difference between Diseased and Disease-free is plotted in fig. 1 as a solid line, and the difference between Badly diseased and Disease-free is plotted as a broken line. Thus, after twelve days desiccation, Diseased has a germination 18.2 per cent higher than Disease-free and hence is plotted as plus 18.2 per cent, while Badly diseased has a germination 7.2 per cent lower than Disease-free and hence is plotted as minus 7.2. In only one instance (two days) does Diseased have a lower germination than Disease-free and Badly diseased a greater germination than either, while Badly diseased consistently shows a lower germination than Disease-free.

The averages of all germinations of desiccated corn are as follows: Diseased, 71.8 per cent; Badly diseased, 48.7 per cent; Disease-free, 50.2 per cent.

The difference in germination in favor of Diseased is clearest where the temperatures are highly injurious; for example, the 90° C. series at fifteen days, the 100° and 90° C. series at seventeen days, and the 100° C. series at twenty-seven days, where almost complete killing occurred in both Disease-free and Badly diseased while Diseased gave a fair percentage of germination.

The differences are not so great in series such as that of 80° C. at four days, where the time of heating was not long enough to be injurious, and the differences may even be in favor of Disease-free or Badly diseased, where very little heat is applied, due probably to the superior vitality of Disease-free when not subjected to high temperatures.

Table 13 brings together the average plumule lengths of the corn treated after desiccation. Although it does not in all cases follow Table 12, yet the relative ranking of the types based on plumule length is very similar to that of the percentages of germination. The average of all plumule lengths shows that

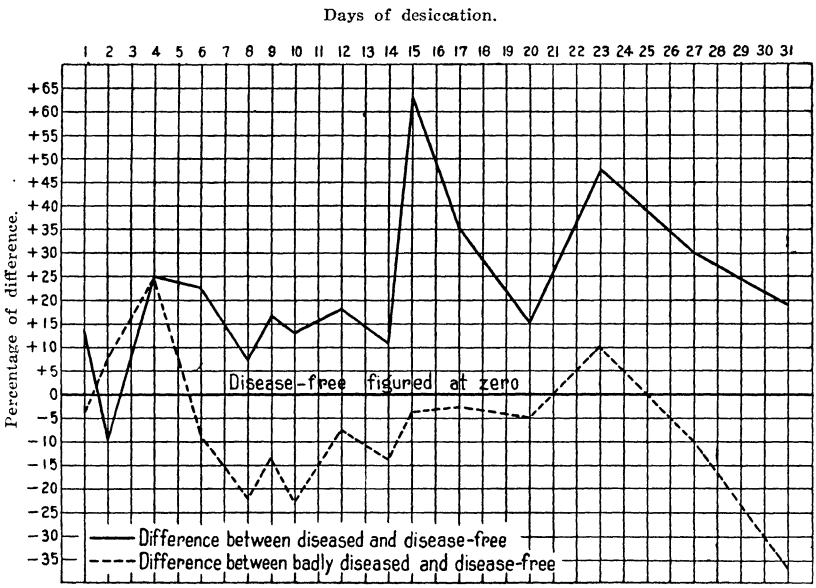


FIG. 1. Graph showing difference in percentage of germination between Diseased and Disease-free corn and between badly Diseased and Disease-free corn, after desiccation and heat treatment.

Diseased corn has the greatest plumule length, Badly diseased the least, and Disease-free is intermediate, plumule length thus having the same ranking as the percentage of germination.

Some difference of opinion has existed and still exists concerning the effects of desiccation on the viability of seeds. Some investigators, notably Ewart (1897), have held that it is impossible to reduce the moisture content of the seed much below 2 to 3 per cent of air-dry weight without affecting germination injuriously. The more recent work of Waggoner (1917), Harrington and Crocker (1918), and Walker (1922) has shown that some seeds can be reduced to a very low moisture

TABLE 12.—*Summary of the average percentages of germination of corn desiccated for various periods of time.*

Type of corn.	Days desiccated.																Average.
	1	2	4	6	8	9	10	12	14	15	17	20	23	27	31	100	
Diseased	92.5	42.0	86.1	77.5	86.3	86.6	90.0	60.9	46.8	66.7	42.5	87.5	76.7	64.5	78.7	63.3	71.8
Badly diseased	75.0	60.0	86.1	46.3	57.6	56.6	55.0	35.5	22.9	0	5.0	67.5	38.9	24.5	23.3	80.0	48.7
Disease-free	79.5	52.0	61.1	55.0	79.4	70.0	77.5	42.7	36.4	3.3	7.5	72.5	28.9	34.5	59.8	43.3	50.2

TABLE 13.—*Summary of the average lengths of plumule (in millimeters) of corn desiccated for various periods of time.*

Type of corn.	Days desiccated.																Average.
	1	2	4	6	8	9	10	12	14	15	17	20	23	27	31	100	
Diseased	100.5	28.0	83.7	87.4	108.1	121.9	116.3	73.5	77.7	79.0	42.4	107.0	93.9	88.2	116.3	129.7	91.4
Badly diseased	62.0	43.0	45.4	58.4	59.1	85.7	48.5	37.2	32.7	0.0	7.0	89.0	36.3	60.7	32.8	43.5	46.3
Disease-free	65.3	49.5	48.4	67.0	78.8	105.4	79.0	32.5	39.4	9.3	6.0	88.2	34.0	63.8	51.3	102.0	57.5

content without injury to their viability. The work of earlier investigators along this line has been reviewed by Harrington and Crocker (1918). In their own work they carefully dried several kinds of seeds in vacuo over calcium oxide and over concentrated sulphuric acid. They reduced the moisture content of Kentucky blue grass seed to 0.1 per cent and then heated it for six hours at 100° C., reducing it still more. The seed thus treated gave only a slightly lowered germination (5 per cent), though its germination energy was considerably reduced. The germination of barley and Sudan grass was not lowered by drying, even though the moisture content was reduced to 0.5 and 0.6 per cent. Johnson grass was slightly injured by being dried to a moisture content of 0.1 per cent. Wheat with moisture content reduced to 0.9 per cent was not injured.

Waggoner (1917) dried radish seed first at 60° C. and then at 100° C., reducing the moisture content to 0.4 per cent without affecting the germination. Walker (1922), in an attempt to control the black-leg fungus of cabbage by desiccation and dry-heat treatment of the seed, reduced the moisture content to 0.72 per cent (dry-weight moisture content) by heating at 85° C., without reducing germination perceptibly; but when the moisture content was reduced to a lower percentage than this by heating twenty-four or more hours at 95° C. the germination was lowered somewhat. He says: "Desiccation at high temperatures (85° C. to 95° C.) caused a gradual reduction in viability, which was accompanied by retardation in germination." He found that "cabbage seed is not uniformly resistant to desiccation at high temperatures."

Corn that had been in desiccators for 100 days contained an average of 2.18 per cent moisture and germinated 87 per cent after being heated 1.5 hours at 100° C. Corn that had been desiccated for 115 days and heated at 70° C. for 32 hours gave 80 per cent germination in soil. A limited amount of corn that had been desiccated for 115 days and heated at 70° C. for 60 hours had a moisture content of 2.14 per cent, very little, if any, moisture having been driven off by the 70° C. heat. As soon as this same corn, desiccated for 115 to 117 days, and further desiccated at 70° C. for 60 hours, was heated at 98° C. in the dry oven for 20 to 32 hours, no germination was obtained, while the moisture content of the different types was 0.71, 1.19, and 1.16 per cent. The injury may have resulted from the high temperature rather than from the extreme desiccation; as my data are limited, it is unwise to draw conclusions therefrom.

MOISTURE DETERMINATIONS

In order to know definitely the amount of moisture present in the corn used and the exact effect of drying over sulphuric acid on the amount of this moisture, it was necessary to make a series of moisture determinations of air-dry corn and corn dried for various periods of time. Two determinations were made in November by the division of crop production, College of Agriculture, University of Illinois, on 100-gram samples, using the Duvel method, resulting in Badly diseased 10.4 per cent and Disease-free 10 per cent. All subsequent determinations were made by placing the corn (10 kernels) in weighed aluminum dishes and reducing to constant weight in an electric drying oven at 100° C.

In Table 14 are given the moisture determinations made on the air-dry and the desiccated corn. The figures are based on

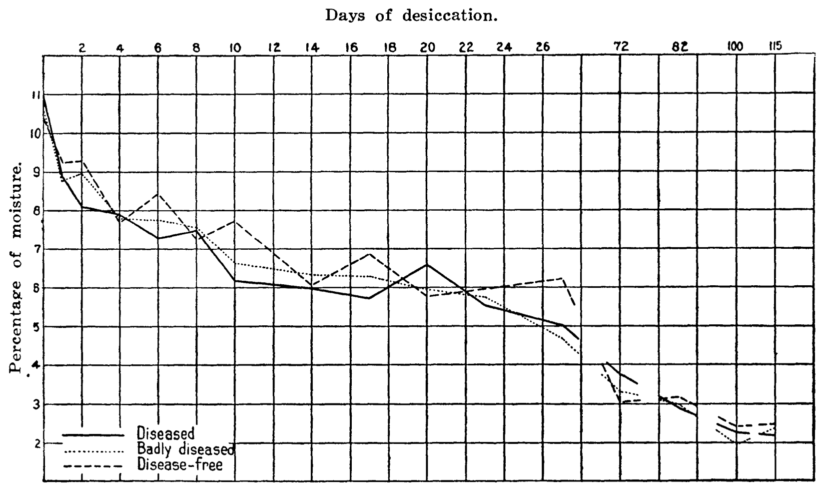


FIG. 2. Graph comparing the moisture content of the three types of corn, air-dry and after varying lengths of time in the desiccator.

single determinations, except air-dry (three determinations) and eight and ten days (two determinations each). The moisture is expressed in percentages, based on the air-dry weight.

Reducing Table 14 to a graph (fig. 2) the moisture relations of the three types of corn can best be expressed by showing relative water loss after different periods of desiccation, up to 27 days. The moisture content of the three types of corn, after 72, 82, and 100 days of desiccation, is shown at the right of the graph. It will be noted that there is a fairly steady decrease in the moisture content. Diseased contains the most moisture in the air-dry condition but soon falls to the least and remains

TABLE 14.—*Moisture content of air-dry and desiccated corn.*

[Moisture content expressed in percentages.]

Type of corn.	Air-dry.	Days desiccated.																
		1	2	4	6	8	10	14	17	20	23	27	72	82	100	115 [a]	115 [b]	115 [c]
Diseased	10.93	8.87	8.09	7.87	7.28	7.49	6.19	5.98	5.70	6.60	5.53	5.02	3.76	2.88	2.23	2.20	2.05	0.71 [d]
Badly diseased	10.64	8.77	8.97	7.79	7.74	7.56	6.46	6.32	6.28	5.94	5.77	4.69	3.32	3.00	1.92	2.73	------	1.19
Disease-free	10.41	9.23	9.28	7.70	8.43	7.22	7.73	6.05	6.87	5.79	5.96	6.30	3.04	3.17	2.40	2.45	2.35	1.16

[a] Heated at 70° C. for 30 hours.

[b] Heated at 70° C. for 60 hours.

[c] Heated at 70° C. for 60 hours; at 98° C. for 20 hours.

[d] Desiccated 117 days; 70° C. for 60 hours; 98° C. for 32 hours.

there fairly constantly; Disease-free contains the least moisture in the air-dry condition but loses water less rapidly and soon contains the most; while Badly diseased maintains an intermediate position.

The fifteen moisture determinations made on corn desiccated from 1 to 115 days, inclusive, given in Table 14, may be grouped according to frequency; that is, the number of times out of the fifteen that each type of corn contains the least, the medium, and the greatest amount of moisture (see Table 15). This is graphically shown in fig. 3, the black spaces indicating the number of times each type of corn contains the least amount of moisture; the clear spaces, the medium amount; and the cross-hatched spaces, the greatest amount.

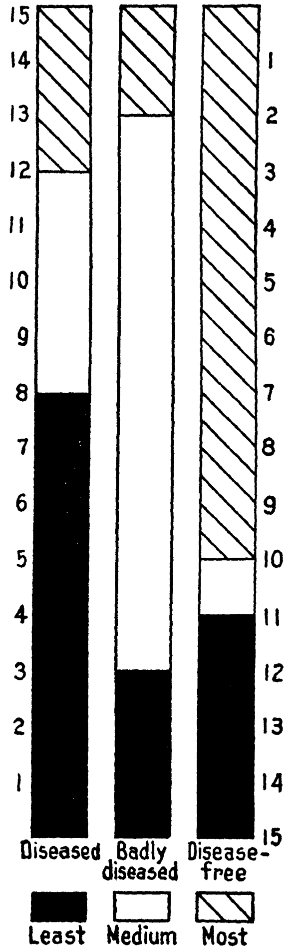


FIG. 3. Graph showing the frequency with which the different types of corn, after varying lengths of time in the desiccator, contained the least, the most, and medium amounts of moisture; based on fifteen determinations.

The differences in amount are not large, however, the average of all moisture contents being as follows: Diseased, 5.71 per cent; Badly diseased, 5.79 per cent; Disease-free, 6.11 per cent.

GRADIENT OF DESICCATION

In the process of desiccation, with the corn in long wire baskets suspended over acid and with the bottom of the basket within 15 millimeters of the surface of the acid and the top within 115 millimeters of the surface, it seemed natural to question whether desiccation was exactly uniform throughout

TABLE 15.—*Number of times, out of fifteen determinations, that each type of corn contains the least, medium, and greatest amounts of moisture.*

Type of corn.	Least.	Medium.	Greatest.
Diseased	8	4	3
Badly diseased	3	10	2
Disease-free	4	1	10

the column of corn. In view of the methods sometimes used to secure moisture or desiccation gradients over water, salt solutions, or mixtures of sulphuric acid and water in open vessels, it was necessary to determine whether complete uniformity of desiccation occurred throughout a tightly closed vessel. The same paraffined wire baskets that were used in desiccation were utilized and only Diseased corn was experimented with. These desiccators were placed in a 30° C. constant temperature case and the corn used after 8, 9, 12, and 16 days desiccation. When ready for testing, the column of corn was divided into three equal parts, upper, middle, and lower, by sticking short pieces of copper wire through the column of corn at the proper places until they formed a network which held the corn so that each third could be removed separately. Each third was then placed in a wire basket in the desiccator so it would not absorb moisture while being tested. Each third made about twelve lots of 10 kernels each, which were tested at a temperature and for a period of time known to be injurious. Thus after 16 days desiccation, 10 kernels from each third of corn were heated 10, 11, 12, and so on up to 32 minutes. Corn desiccated 8, 9, and 12 days was heated at 90° C., while corn desiccated 16 days was heated at 100° C. The results of these series are summarized in Table 16.

TABLE 16.—*Summary of the desiccation gradient of Diseased corn.*

PERCENTAGE OF GERMINATION.

Position in desiccator.	Days desiccated.				Average.
	8	9	12	16	
Upper	84.0	70.9	35.5	70.8	65.3
Middle	75.0	63.3	37.7	68.5	63.6
Lower	66.0	60.0	32.2	68.5	56.6
Difference between upper and lower	18.0	10.9	3.3	2.3	8.7

LENGTH OF PLUMULE IN MILLIMETERS.

Position in desiccator.	Days desiccated.				Average.
	8	9	12	16	
Upper	78.0	67.1	59.3	78.8	70.8
Middle	73.0	60.0	69.0	79.2	70.3
Lower	72.0	70.6	53.6	75.2	67.9
Difference between upper and lower	6.0	3.5	6.3	3.6	2.9

From the data in Table 16 it is evident that the corn from the upper one-third of the basket, which was farthest from

the surface of the acid, was the most resistant to heat, while that from the lower one-third, closest to the acid, was the least resistant. To reduce to a single figure the difference in germination between the upper and the lower parts, the percentage of germination of the lower was subtracted from that of the upper and the resulting figure given at the foot of each section of the table. These figures indicate that after 8 days of desiccation the corn in the upper one-third gave 18 per cent better germination after heating than that in the lower. With increased desiccation, the difference became less, until after 16 days it was only 2.3 per cent. It would probably slowly approach zero as a limit so that with time the desiccation would become uniform throughout. Data are not available to indicate what the ratio would be following 1 to 8 days desiccation; but it probably would describe a regular curve, as there is little difference after a short period of drying and the difference increases rapidly to a climax and then slowly decreases to zero, the climax coming on or before the eighth day of desiccation.

The length of plumule varies more widely, as is usual, but the averages rank the same as the percentages of germination. The difference between the upper one-third and the lower one-third is slight throughout the series, but is always in favor of the upper.

Only one kind of corn (Diseased) having been used, the difference in resistance to heat of the corn in the upper and lower thirds of the basket must be due to a difference in moisture content. To determine what difference existed, moisture determinations were made after 17 days desiccation of corn from the upper, middle, and lower parts of the basket, with the following results: Upper, 5.70 per cent; middle, 6.03 per cent; lower, 6.30 per cent, giving a difference of 0.60 per cent in favor of the upper. This indicates that the greater resistance to heat of the corn in the upper one-third of the basket as compared with that of the lower one-third was due to its lesser moisture content. In view of this slight difference in desiccation care was taken always to have the upper part of the column of corn the same distance from the surface of the acid in each of the three types of corn under test, so as not to introduce an error.

DAILY VARIATION

It was readily noticeable, in the heating tests, that varying results were obtained on successive days, even though the same type of corn, the same degree of heat, and the same period of exposure were used. This seemed to be correlated with out-

side climatic conditions (humidity) and, as the ventilators in the laboratory were open part of the time, the laboratory air varied in humidity also. To simulate conditions under which corn would be stored in open cribs on the farms of Illinois, shelled corn of the three types was placed in wire baskets and hung outdoors, under a rooflike shelter, suspended on a wire strung between two wings of the greenhouse, open to all air currents but protected from direct sunlight and from rain. Tests made on this corn in March and April will serve as a guide in treating crib corn for fungous or insect pests, during the rainy spring season, by means of heat, and will give the limits of time and temperature beyond which injury to germination would result. Furthermore, it was desirable to find out if the variation in the same test from day to day was actually due to variation in relative humidity of the air and, if so, how rapidly and to what extent the variation in moisture content of the corn followed the variations in atmospheric humidity. The variation in moisture content of the corn was not measured directly but was measured by the variation in percentage of germination following heat treatment; a low germination indicated a high moisture content of the corn, correlated with a high relative humidity of the atmosphere.

A check test was made on the air-dry corn just before it was hung outdoors (on March 28) and at intervals afterward up to April 26. Each test consisted of a check and ten kernels of each type of corn heated at 90° C. for 3, 4, 5, 6, 7, 8, and 9 minutes.

The percentages of germination of each type of corn, after the heat treatments, were added and the totals used to construct the graph in fig. 4. Thus, on April 2, Diseased, Badly diseased, and Disease-free corn from the baskets hanging outdoors was treated at 90° C. with the result in germination indicated in Table 17. The total does not include the check, which did not vary. The totals for each test are summarized in Table 18.

TABLE 17.—*Result of heating corn which had been exposed to outdoor climatic conditions.*

[Numbers give percentages of germination.]

Type of corn.	Check.	Minutes heated.							Total.
		3	4	5	6	7	8	9	
Diseased	100	100	70	50	40	0	0	0	260
Badly diseased	100	90	90	80	30	0	0	0	290
Disease-free	100	90	70	60	30	0	0	0	250

TABLE 18.—*Daily variation in the germination of corn exposed to outdoor climatic conditions.*

[Numbers give totals of germination percentages.]

Type of corn.	March—			April—															
	[a] 28	29	30	1	2	5	6	8	9	11	12	15	16	17	19	20	22	23	24	26
Diseased	390	250	210	210	260	120	130	180	140	130	200	180	120	180	220	160	180	200	203	140
Badly diseased	430	300	280	290	290	210	180	140	230	180	250	250	230	180	240	270	280	340	260	200
Disease-free	430	340	280	240	250	130	180	90	220	270	220	220	160	230	220	230	200	260	290	170
Average	417	297	257	247	267	153	163	137	197	193	223	217	170	197	227	220	220	267	251	153

[a] Check test.

The data on relative humidity were obtained from the division of soil physics, College of Agriculture, University of Illinois. In this division daily relative humidity readings are taken at 7 a. m., 2 p. m., and 7 p. m. My heating tests were not made coincident with the observed readings, but the nearest humidity reading was taken as the one to be graphed. Thus, if the corn was tested at 3 p. m. on April 2, the relative humidity reading taken on that day at 2 p. m. was the one used.

In fig. 4 the broken line indicates the relative humidity, and the solid line the average of the total germinations. It was found, upon graphing the germination totals for each type of corn separately, that no type followed the changes in relative

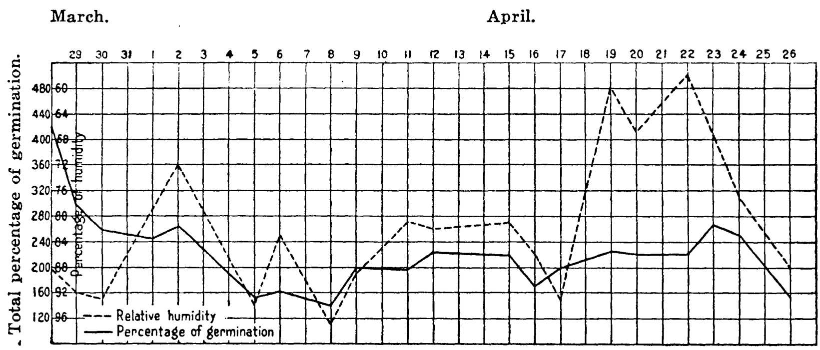


FIG. 4. Graph showing daily variation in percentage of germination and relative humidity.

humidity more closely than another. For the sake of clearness, therefore, the totals for the three types were averaged and the graph made from these data. The variation of the three types followed that of the relative humidity closely where the changes were great and continued for several days, such as the great drop from April 2 to 5 and that from April 23 to 26; but where the changes were smaller and less prolonged, as April 11 and 12, one type might follow the change in relative humidity while the other two types might vary in the opposite direction, or vice versa.

It would not be justifiable, from the data at hand, to say that one type varies more widely or more rapidly under outdoor conditions than another; but it can be said that with few exceptions the average resistance to heat, of corn stored in the open, varies inversely to the changes in relative humidity of the atmosphere. Where the curves do not coincide the differences are not great and could probably be explained by a wide change in humidity

before the test was made or, more probably, by the moisture content of the corn lagging behind the changes in relative humidity of the atmosphere.

The germination totals of Diseased were low; those of Disease-free, high; and those of Badly diseased, intermediate. This relation held rather consistently throughout the entire test.

A graph of the average total plumule lengths varied more widely than did that of the percentages of germination and, while following in the main the changes in relative humidity, did not follow as closely as did that of the percentages of germination; hence it was not included in fig. 4.

A moisture determination was made on April 26, at the time the test was made. The day was warm and humid, and the kernels of corn while being handled fell on the table with a dull thud. From the graph we see that the humidity was low, but not the lowest reached during the test. The moisture determinations were as follows: Diseased, 14.86 per cent; Badly diseased, 14.60 per cent; Disease-free, 14.44 per cent. This bears out the statement that Diseased, in the air-dry condition, contains the most moisture and Badly diseased and Disease-free lesser amounts, in the order named. The average total germination on that day was one of the lowest in the table.

PLACING IN WATER AFTER HEATING

Just (1875), in working with seeds of *Trifolium pratense,* said that seeds heated at 100° C. germinated if after heating they were supplied with water slowly, but did not germinate if supplied with water rapidly. An extensive series of experiments was undertaken to see if placing in water immediately after heating to high temperatures had any effect on the germination of corn, and further, to learn if the sudden intake of water and the sudden cooling injured the viability of the kernels.

The corn was heated in phials in duplicate sets and immediately after heating, while the phials were still hot, the corn from one set was placed in tap water at room temperature, while the corn from the other set was placed in aluminum dishes to cool. After the first set had soaked four hours it was taken out and placed between moist blotting paper, to prevent drying out, and the second set soaked four hours; thus each set was soaked for an equal period of time. At the end of the second four hours both sets were placed in rag dolls and these placed in the germinator jars as usual. Two trials were made, in-

volving air-dry corn heated at 80° and at 90° C., and corn which had been desiccated nineteen days, heated at 100° C. The entire result is summarized in Table 19. Air-dry corn was averaged separately from desiccated, to determine any difference in resistance.

TABLE 19.—*Effect of placing corn in water immediately after heating.*

[W, corn placed in water immediately after cooling; A, corn placed in aluminum dishes to cool.]

Type of corn.	First trial.				Second trial.			
	Air-dry.		Desiccated.		Air-dry.		Desiccated.	
	W	A	W	A	W	A	W	A
Diseased ....per cent..	91.7	86.6	87.7	91.1	56.7	53.3	81.8	71.0
Badly diseased ....do....	93.3	88.3	53.9	51.4	60.0	58.3	46.7	51.7
Disease-free ....do....	90.6	85.0	58.3	63.3	46.7	53.3	49.2	46.7
Average............	91.9	86.6	66.6	68.6	54.5	55.0	59.2	56.5
Average length of plumule...mm..	113.0	118.4	72.2	27.6	72.8	53.4	72.3	83.5

From Table 19 it is evident that there is no consistent variation due to placing the corn in water after heating. In the first trial, in air-dry corn, the germination was best in that placed in water immediately after cooling and the plumule length was least. In desiccated corn, the germination was best in that placed in almuninum dishes to cool and the length of plumule was least. This is exactly reversed in the second trial. The differences, moreover, were not large. It can be said, therefore, that placing corn in water immediately after heating has no effect whatever on either the percentage of germination or on the length of plumule.

GROWTH OF HEATED CORN IN SOIL

To determine the effect of heating the kernels upon the germination of corn in soil and the subsequent growth and the green weight of the seedling, corn of the three types was heated and then planted in rows, in garden loam in a bench in the middle of the greenhouse, equally lighted and heated from all sides. Air-dry corn was heated at 80° C. for 5, 7.5, 10, 12.5, and 15 minutes and was planted 0.75 inch deep. Corn that had been in the desiccator for 16 days was heated at 90° C. for 110, 130, 140, and 150 minutes and was planted the same way. Checks of each were also planted. Ten kernels of each type were used for each period of heating.

There was a noticeable retardation in the germination and growth of corn heated most severely, in both the air-dry and

the desiccated lots. In digging up the kernels many were found to have put out a short plumule or radicle, but they did not have growth energy enough to force their way to the surface. This probably accounts for much of the difference between the results obtained in rag dolls and the result obtained in the soil, for the germination in rag dolls was 60 per cent and in soil, 27.8 per cent, in a series using air-dry corn heated at 80° C. Records were taken of the time of appearance of the shoots above the soil, and height measurements were taken at the end of thirty days, at which time the plants were harvested by cutting off the stalk at the surface of the soil, and the green weight was taken. The results of the above planting are recorded in Tables 20 and 21.

TABLE 20.—*Growth of air-dry corn heated at 80° C., and planted in soil.*

Treatment.	Type of corn.	Germination.	Total green weight.	Average green weight per plant.	Height per plant.
		Per cent.	*g.*	*g.*	*cm.*
Check	Diseased	100	47.85	4.785	59
Do	Badly diseased	100	37.65	3.765	59
Do	Disease-free	90	40.25	4.472	56
Heated 5 minutes	Diseased	100	43.00	4.300	62
Do	Badly diseased	70	23.10	3.300	55
Do	Disease-free	90	41.97	4.663	57
Heated 7.5 minutes	Diseased	100	40.10	4.010	54
Do	Badly diseased	70	31.23	4.461	52
Do	Disease-free	100	55.97	5.597	64
Heated 10 minutes	Diseased	60	6.95	1.158	30
Do	Badly diseased	60	29.32	4.887	61
Do	Disease-free	60	14.98	2.497	43
Heated 12.5 minutes	Diseased	10	0.81	0.810	28
Do	Badly diseased	10	0.52	0.520	24
Do	Disease-free	30	7.65	2.550	37
Heated 15 minutes	Diseased	0	0	0	0
Do	Badly diseased	0	0	0	0
Do	Disease-free	0	0	0	0
Average	Diseased	67.5	22.72	2.570	43.5
Do	Badly-diseased	52.5	21.04	3.292	48.0
Do	Disease-free	70.0	30.14	3.827	50.3

In the air-dry corn (Table 20) no germination resulted after the 12.5-minute heating. Disease-free corn consistently had a higher percentage of germination, total green weight, average green weight per plant, and height. Badly diseased varied widely, being high in average green weight per plant and height per plant, but low in germination and total green weight. This was probably due to the fact that Badly diseased frequently

had a few highly resistant kernels which produced large plants. This is even more noticeable in Table 21 where, at temperatures that killed practically all the kernels, Badly diseased occasionally sent up a fairly vigorous seedling. The inherent weakness of Badly diseased is shown by its low germination. Diseased was high in germination and in total green weight, but low in average green weight per plant and height per plant.

TABLE 21.—*Growth of corn which had been desiccated for 16 days, heated at 90° C., and planted in soil.*

Treatment.	Type of corn.	Germination.	Total green weight.	Average green weight per plant.	Height per plant.
		Per cent.	*g.*	*g.*	*cm.*
Check	Diseased	100	39.70	3.970	53
Do	Badly diseased	80	29.35	3.670	49
Do	Disease-free	100	39.25	4.242	51
Heated 110 minutes	Diseased	70	16.95	2.421	43
Do	Badly diseased	10	2.00	2.000	40
Do	Disease-free	0	0	0	0
Heated 120 minutes	Diseased	90	33.10	3.678	48
Do	Badly diseased	0	0	0	0
Do	Disease-free	0	0	0	0
Heated 130 minutes	Diseased	60	10.00	1.667	34
Do	Badly diseased	10	0.47	0.470	21
Do	Disease-free	0	0	0	0
Heated 140 minutes	Diseased	60	9.80	1.633	30
Do	Badly diseased	0	0	0	0
Do	Disease-free	10	3.00	3.000	43
Heated 150 minutes	Diseased	70	14.90	2.129	38
Do	Badly diseased	0	0	0	0
Do	Disease-free	0	0	0	0
Average	Diseased	70.0	16.95	[a] 2.764	[a] 38.6
Do	Badly diseased	4.0	4.92	[a] 1.235	[a] 30.5
Do	Disease-free	2.0	.60	[a] 3.000	[a] 43.0

[a] Average of those plants that grew.

Table 21 shows the reverse of Table 20. It is an extreme example of the superior resistance to heat of Diseased corn after desiccation. This is shown especially in the percentage of germination. An occasional resistant kernel, especially in Badly diseased, but also in Disease-free, sent up a seedling even after severe heat treatment of the kernels; Diseased, however, shows remarkable germination throughout. The average height per plant was much greater in Disease-free, and the averages of the plants that grew are the following: Diseased, 38.6 centimeters; Badly diseased, 30.5 centimeters; Disease-free, 43 centimeters. The same ratio holds in green weight per plant.

CONCLUSIONS

1. Air-dry corn, containing 10 to 11 per cent moisture, is killed by exposure to 80° and 90° C. for 25 and 10 minutes, respectively, and is injured by exposure to 70°, 80°, and 90° C. for 80, 10, and 5 minutes, respectively.

2. The resistance of corn to high temperatures varies inversely as its water content at the time of heating.

3. Under air-dry conditions, Diseased corn contains the most moisture, Disease-free the least moisture, and Badly diseased an intermediate amount. Their resistance to heat is inversely proportional to their moisture content.

4. After desiccation over sulphuric acid Diseased corn contains the least moisture, Disease-free the most moisture, and Badly diseased an intermediate amount.

5. After desiccation Diseased corn is very much more resistant to heat, compared with Disease-free and Badly diseased corn, than its slightly less moisture content would indicate. This greater resistance becomes evident only as the temperatures become injurious.

6. After desiccation, Diseased corn is most resistant to heat, Disease-free less resistant, and Badly diseased is least resistant in spite of its moisture content being less than that of Disease-free corn. The last difference may be explained by the superior vigor of Disease-free and the diseased and weakened condition of Badly diseased.

7. Desiccation brings about changes in the corn that cause Diseased to become very resistant to heat, and Badly diseased to become less resistant. What these changes are is not known.

8. Desiccation over sulphuric acid in a closed vessel is not uniform; it is greatest farthest from the surface of the acid, and least closest to it. This gradient gradually lessens as the length of time of desiccation increases.

9. The resistance to heat of air-dry corn, both in the laboratory and outdoors, varies with the variations in climatic conditions (humidity). The three kinds of corn tested vary in a similar manner.

10. Placing the heated corn in water immediately after treatment has no injurious effect on its viability.

11. Germination of heated corn is better in rag dolls than in soil.

12. Amount of growth of the seedlings follows, in general, the percentage of germination of the treated and untreated corn.

13. The percentages of germination, green weight, and height of plants of heated corn grown in soil parallel the behavior shown in germination in the rag dolls. In air-dry corn Disease-free is consistently highest, Diseased lowest, and Badly diseased intermediate. In desiccated corn Diseased is consistently highest, Disease-free usually lowest, and Badly diseased varies between lowest and intermediate.

LITERATURE CITED

ATANASOFF, D., and JOHNSON, A. G. Treatment of cereal seeds by dry heat. Journ. Agr. Res. **18** (Jan., 1920) 379–390.

BRANSTETTER, B. B. Treatment of seed to control root and stalk rots. Abst. Phytopath. **12** (1922) 30.

BURGESS, J. L. Relation of varying degrees of heat to the viability of seeds. Journ. Am. Soc. Agron. **11** (1919) 118–120.

DE ONG, E. R. Effect of excessive sterilization measures on the germination of seeds. Journ. Econ. Ent. **12** (1919) 343–345.

DICKSON, J. G. Dry heat treatment for control of cereal seed-borne diseases. Annual Report of the Director, 1919–1920. Wisc. Agr. Exp. Sta. Bull. **323** (Dec., 1920).

DUDDLESTON, B. H. The modified rag doll and germinator box. Purdue University Agr. Exp. Sta. Bull. **236** (1920).

EWART, A. J. On the power of withstanding desiccation in plants. Proc. and Trans. Liverpool Biol. Soc. **11** (1897) 151–159.

GOODWIN, W. H. Heat for control of cereal insects. Ohio Agr. Exp. Sta. Bull. **354** (1922).

GROVES, J. F. A method of prophesying the life duration of seeds. Trans. Ill. Acad. Sci. **8** (1915) 133–136.

GROVES, J. F. Temperature and life duration of seeds. Bot. Gaz. **63** (1917) 169–189.

HABERLANDT, I. Die oberen und unteren Temperaturgrenzen für die Keimung der wichtigeren Samereien. Landw. Versuchsstation **17** (1874) 104–116.

HARRINGTON, GEORGE T., and CROCKER, WILLIAM. Resistance of seed to desiccation. Journ. Agr. Res. **14** (1918) 525–532.

JUST, L. Wirkung höherer Temperaturen auf die Keimfähigkeit der Samen. Bot. Zeit. **33** (1875) 51–52.

LEHENBAUER, P. A. Growth of maize seedlings in relation to temperature. Phys. Res. No. 5 **1** (1914) 247–288.

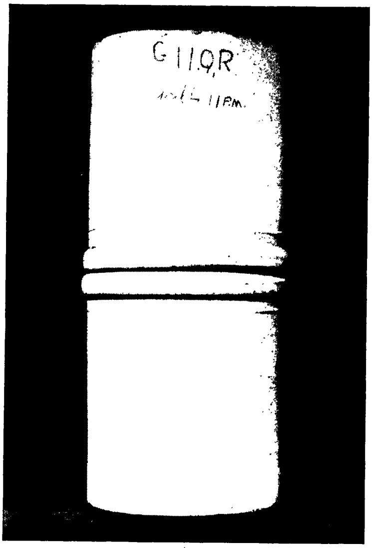
MONTGOMERY, E. G. Heating seed rooms to destroy insects. Journ. Am. Soc. Agron. **9** (1917) 105–108.

WAGGONER, H. D. The viability of radish seeds (Raphanus sativus L.) as affected by high temperatures and water content. Am. Journ. Bot. **4** (1917) 299–313.

WALKER, J. C. Seed treatment and rainfall in relation to the control of cabbage black-leg. U. S. Dept. Agr. Bull. **1029** (1922) 1–27.

WHITE, JEAN. The ferments and latent life of resting seeds. Proc. Royal Soc. London, Series B **81** (1909) 417–441.

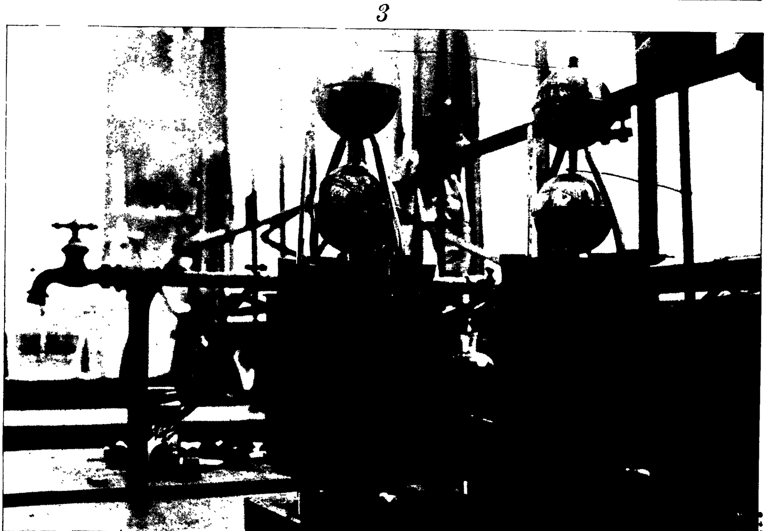
ILLUSTRATIONS



1

2

3



4

PLATE 1.

NEW SPECIES OF MELOLONTHID BEETLES FROM THE PHILIPPINE ISLANDS

By J. MOSER

Ellrich im Harz, Germany

Neoserica opacula sp. nov.

♂. *N. luzonicae* Mos. similis, femoribus tibiis que posticis paulo latioribus. Opaca, supra nigro-fusca, subtus rufo-fusca. Capite, fronte opaca, clypeo subrugoso, margine antico elevato, leviter sinuato; antennis rufoflavis, flabello maris 4-articulato, stipiti longitudine fere aequali; prothorace postice duplo latiore quam longiore, antrorsum angustato, lateribus curvatis, ciliatis, angulis anticis acutis, porrectis, angulis posticis obtusis, rotundatis, margine antico medio leviter producto, dorso subtiliter punctato; elytris seriato-punctatis, interstitiis paulo convexis, sparsim punctis obtectis; pygidio sat remote umbilicato-punctato, punctis minutissime setosis. Subtus pectore utrinque juxta medium erecte setoso, pectoris lateribus coxisque posticis umbilicato-punctatis, coxis juxta latera setis instructis; abdominis segmentis transversim setosis; femoribus posticis sat latis, opacis, ante marginem posticum setis nonnullis sat validis vestitis, margine postico in parte apicali sinuato; tibiis posticis dilatatis et abbreviatis. Long. 8.5 mm.

SIBUYAN (*C. F. Baker*).

Apogonia imugana sp. nov.

Oblonga, postice parum modo ampliata, nigra, nitida, cupreomicans. Capite, fronte sat remote subtiliter, clypeo fortiter subrugoso-punctato, clypei margine antico late sinuato, angulis rotundatis; prothorace transverso, lateribus fortiter curvatis, angulis anticis fere rectangulis, perparum modo productis, angulis posticis rotundatis, dorso medio sparsim, juxta latera paulo densius subtiliter punctato; scutello lax subtilissime punctato; elytris dorso subtiliter punctatis, juxta latera transversim rugosis, costis indistinctis, sparsim punctis obtectis; pygidio rugoso-punctato, erecte griseo-piloso. Subtus pectoris medio parce, abdominis medio densius punctato, pectoris abdominisque

lateribus confertim punctis griseo-setosis instructis; abdominis lateribus haud carinatis; pedibus gracilibus, tibiis anticis tridentatis. Long. 12 ad 13 mm.

LUZON, Nueva Vizcaya Province, Imugan (*G. Boettcher*) V. 1916.

Apogonia callosifrons sp. nov.

♂. Oblongo-ovalis, subopaca, nigro-fusca, paulo cuprascens. Capite mediocriter dense punctato, clypei basi carinata, clypei margine antico late rotundato, medio subsinuato, fronte post carinam bicallosa; prothorace transverso, medio rotundato-dilatato, angulis anticis acutis, productis, angulis posticis obtusis, subrotundatis, dorso mediocriter crebre punctato; elytris leviter rugosis, sat remote punctatis, costis valde indistinctis; pygidio parce punctato, postice erecte piloso. Subtus pectoris medio subtiliter, pectoris lateribus coxisque posticis fortius punctatis, abdomine mediocriter dense punctis obtecto, abdominis lateribus haud carinatis; pedibus posticis gracilibus, tibiis anticis tridentatis. Long. 12 mm.

LUZON, Nueva Vizcaya Province, Imugan (*Baker*).

Apogonia banosana sp. nov.

♂. *A. palawanae* Heller similis, praecipue differt; tibiis anticis bidentatis. Nigra, nitida, paulo cupreo-micans. Capite, fronte remote, clypeo dense punctato, clypei margine antico late rotundato; antennis fulvis; prothorace fere clypeo latiore quam longiore, lateribus leviter curvatis, angulis anticis fere rectangulis, parum productis, angulis posticis rotundatis, dorso mediocriter crebre punctato; scutello punctis nonnullis instructo; elytris sat remote punctatis, costis fere planis; pygidio corporeque infra parce, pectoris lateribus paulo densius, punctatis, abdominis lateribus haud carinatis; femoribus posticis angustis, tarsis fuscis. Long. 7 mm.

LUZON, Laguna Province, Los Baños (*Baker*).

Apogonia tangcolana sp. nov.

♂. Oblongo-ovalis, nitida, supra nigro-fusca, subtus fusca. Capite sat dense punctato, clypeo antrorsum angustato, margine antico leviter sinuato, angulis anticis rotundatis; antennis flavo-testaceis; prothorace duplo latiore quam longiore, paulo post medium rotundato-dilatato, angulis anticis et posticis obtusis, illis haud productis, dorso sat crebre punctato; scutello fere laevi; elytris subrugoso-punctatis, costis parum distinctis; pygidio parce punctato. Subtus pectoris medio fere impunctato,

pectoris lateribus dense punctis griseo-setosis obtectis; abdomine medio parce, juxta latera paula densius punctato, punctis setis minutis vestitis, abdominis lateribus carinatis; femoribus rufo-fuscis, posticis ante marginem posticum setosis; tibiis anticis bidentatis, tarsis anticis et mediis in mare dilatatis. Long. 6 mm.

MINDANAO, Bukidnon Province, Tangcolan (*Baker*).

Apogonia latitarsis sp. nov.

♂. Oblongo-ovalis, nitida, supra viridi-fusca, subtus fusca. Capite sat dense punctato, clypeo producto, antrorsum angustato, margine antico sinuato, angulis acutis; antennis flavo-testaceis; prothorace latiore quam longiore, lateribus fortiter curvâtis, angulis anticis fere rectangulis, angulis posticis obtusis, dorso subtiliter punctato; scutello laevi; elytris seriato-punctatis, interstitiis paulo convexis, fere laevibus; pygidio fortiter punctato, punctis griseo-squamoso-setosis. Corpore infra griseo-squamoso, abdominis lateribus haud carinatis, femoribus posticis sat latis, tibiis anticis bidentatis, tarsis anticis et mediis in mare fortiter dilatatis. Long. 6.5 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

Apogonia benguetana sp. nov.

A. monticolae Mos. similis, supra paulo densius punctato. Nigra, subtus nigro-fusca. Capite, fronte mediocriter crebre clypeo densius punctato, clypei margine antico rotundato; antennis fulvis; prothorace duplo latiore quam longiore, post medium rotundato-dilatato, angulis anticis fere rectangulis, angulis posticis obtusis, dorso sat crebre punctato; scutello laevi; elytris sat dense fortiter punctatis, costis laevibus; pygidio grosse punctato, punctis griseo-pilosis. Subtus parce punctato, punctis setis griseis vestitis, abdominis lateribus carinatis; pedibus gracilibus, tibiis anticis acute tridentatis. Long. 7 ad 8 mm.

LUZON, Benguet (*Boettcher*) V. 1914.

Apogonia nigripennis sp. nov.

Parva, ovalis, rufa, nitida, fronte elytrisque nigris. Capite mediocriter crebre punctato, clypei margine antico elevato, late subrotundato; prothorace longitudine plus duplo latiore, lateribus fortiter curvatis, angulis anticis paulo productis, angulis posticis rotundatis, dorso sat dense punctato; scutello parce punctulato; elytris sat crebre punctatis, costa prima postice dilatata; pygidio plano, sat remote punctato, punctis brevissime

setosis. Subtus medio parce, juxta latera densius punctato, punctis setis minutis griseis instructis, abdominis lateribus haud carinatis; tibiis anticis tridentatis. Long. 6 mm.

MINDANAO, Kolambugan (*Baker*).

Apogonia polisana sp. nov.

♂. Oblongo, rufo-fusca, nitida. Capite rugoso-punctato, clypeo antrorsum angustato, lateribus subsinuatis, margine antico paulo reflexo, truncato, levissime sinuato, angulis anticis rotundatis; antennis ferrugineis; prothorace transverso, medio rotundato-dilatato, angulis anticis productis, parum acutis, angulis posticis obtusis, subrotundatis, dorso mediocriter crebre punctato; scutello laevi; elytris levissime rugosis, costis parce, interstitiis densius punctatis, costa prima postice dilatata; pygidio grosse rugoso-punctato, punctis pilosis. Subtus medio parce, juxta latera sat dense punctato, punctis griseo-setosis, abdominis lateribus carinatis; pedibus gracilibus, tibiis anticis bidentatis. Long. 9 mm.

LUZON, Mountain Province, Mount Polis (*Boettcher*) II. 1917.

Apogonia surigaoana sp. nov.

A. viridimicanti Mos. similis, differt clypeo maris fortiter producto, margine antico sinuato, angulis acutis. Rufo-flava, nitida. Capite mediocriter crebre punctato; prothorace dimidia parte latiore quam longiore, lateribus fortiter curvatis, angulis anticis fere rectangulis, perparum productis, angulis posticis rotundatis, dorso mediocriter dense punctato; scutello fere laevi; elytris subrugoso-punctatis, costis sublaevibus; pygidio fortiter punctato, punctis pilosis. Subtus medio laxe, ad latera versus densius puntacta, punctis albo-squamosis, abdominis lateribus haud carinatis; femoribus posticis remote squamis albis vestitis, tibiis anticis bidentatis. Long. 5 mm.

MINDANAO, Surigao (*Baker*).

Apogonia maculipennis sp. nov.

Oblongo-ovalis, viridi-fusca, nitida, elytris pygidioque flavis, viridi-fusco-maculatis, pedibus rufis. Capite dense punctato, clypeo antrorsum angustato, margine antico truncato, levissime sinuato, angulis anticis rotundatis; antennis ferrugineis; prothorace duplo latiore quam longiore, medio rotundato-dilatato, angulis anticis acutis, productis, angulis posticis obtusis, dorso mediocriter crebre subtiliter punctato; scutello juxta latera sub-

tilissime punctulato; elytris leviter rugosis, mediocriter crebre et irregulariter punctatis, flavis, maculis numerosis, subseriatim positis, viridifuscis; pygidio alutaceo, pilifero-punctato, medio longitudinaliter carinato. Subtus medio sat remote, juxta latera densius punctato, punctis pilosis, pectoris medio longitudinaliter sulcato, abdominis lateribus haud carinatis, tibiis anticis tridentatis. Long. 8 mm.

LUZON, Mountain Province, Pauai (Haight's place) (*Boettcher*) III. 1916.

Apogonia angustipes sp. nov.

Oblongo, postice paulo dilatata, fusca, nitida, griseo-pilosa. Capite pilifero-punctato, clypeo margine antico paulo reflexo, late rotundato, sutura clypeali impressa, bisinuata, clypeo ante carinam leviter convexo; antennis ferrugineis; prothorace transverso, medio rotundato-dilatato, angulis anticis productis, acutis, angulis posticis rotundatis, dorso sat dense punctato, punctis pilis suberectis vestitis; scutello crebre pilifero-punctato; elytris leviter rugosis, mediocriter dense punctatis, punctis suberecte pilosis, costis convexis; pygidio pilifero-punctato, pilis erectis, pygidii medio levissime longitudinaliter sulcato. Subtus sat dense punctato, punctis pilosis, pectoris medio sulco instructo, abdominis lateribus haud carinatis; pedibus gracilibus, tibiis anticis tridentatis. Long. 14 mm.

LUZON, Mountain Province, Pauai (Haight's place) (*Boettcher*) III. 1917.

Apogonia philochlaenioides sp. nov.

♂. Oblongo-ovalis, cuprea, nitida, paulo aeneo-micans, griseo-pilosa. Capite dense punctato, punctis erecte pilosis, clypeo antrorsum angustato, margine antico reflexo, leviter sinuato, angulis anticis rotundatis; antennis ferrugineis; prothorace longitudine plus duplo latiore quam longiore, lateribus curvatis, angulis anticis acutis, productis, angulis posticis obtusis, dorso sat crebre subtiliter punctato, punctis pilis erectis vestitis; scutello pilifero-punctato; elytris alutaceis, subrugoso-punctatis, punctis pilosis, pilio adpressis vel erectis, maculis numerosis glabris, tuberculiformibus, costis indistinctis; pygidio rugoso, erecte piloso. Subtus mediocriter dense pilifero-punctato, abdominis lateribus carinatis; tibiis anticis tridentatis dente primo minuto. Long. 7 mm.

LUZON, Mountain Province, Balbalasang (*Boettcher*) III. 1918.

Apogonia griseosquamosa sp. nov.

Oblongo-ovalis, fusca, paulo cuprascens, griseo-squamosa. Capite dense punctato, punctis squamosis, fronte viridiscente, clypeo margine antico paulo elevato, truncato, subsinuato, angulis rotundatis; antennis testaceis; prothorace longitudine fere duplo latiore, lateribus curvatis, angulis anticis productis, acutis, angulis posticis obtusis, dorso dense semiannulato-punctato, punctis squamis ovatis vestitis; scutello squamifero-punctato; elytris sat crebre squamis ovalibus obtectis, costis indistinctis; pygidio rugoso-punctato, punctis erecte pilosis, in pygidii parte basali squamosis. Subtus dense griseo-squamosa, abdominis lateribus carinatis; tibiis anticis tridentatis. Long. 7 mm.

MINDANAO, Surigao Province, Surigao (*Boettcher*) V. 1915.

Leucopholis bakeri sp. nov.

L. irroratae Chev. similis, differt; squamis minoribus, clypei margine antico minus elevato, prothoracis lateribus ante medium paulo distinctius sinuatis, angulis anticis magis rotundatis, processu mesosternali paulo breviore, apice excepto, pilifero-punctato. Long. 22 ad 23 mm.

MINDANAO, Dapitan (*Baker*).

Leucopholis reflexa sp. nov.

♂. *L. irroratae* Chev. similis, praecipue differt; clypei margine antico obtuse triangulari, fortiter reflexo. Long. 29 ad 30 mm.

MINDANAO (*Baker*).

Holotrichia imugana sp. nov.

♂. *H. flachi* Brsk. similis, differt prothoracis angulis anticis magis productis. Fusca, opaca. Capite medio leviter longitudinaliter impresso, fronte parce subtiliter, clypeo fortius punctato, clypei margine antico paulo reflexo, sinuato, angulis rotundatis; antennarum flabello maris parvo; prothorace duplo latiore quam longiore, medio rotundato-dilatato; lateribus haud crenulatis, ante medium leviter sinuatis, angulis anticis acutis, productis, angulis posticis rotundatis, dorso remote subtiliter punctato; scutello punctis nonnullis instructo; elytris leviter costatis, sat sparsim umbilicato-punctatis, punctis minutissime setosis; pygidio parce umbilicato-punctato. Subtus pectore coxisque posticis flavido-villosis, abdominis lateribus sparsim

pilosis; articulo primo tarsorum posticorum secundo parum breviore, unguibus dente mediano armatis. Long. 28 mm.

LUZON, Nueva Vizcaya Province, Imugan (*Boettcher*) 30. I. 1916.

Holotrichia banahaoensis sp. nov.

H. flachi Brsk. similis, differt prothorace postice minus constricto. Fusca vel nigro-fusca, opaca. Capite, fronte mediocriter crebre punctato, clypeo paulo rugoso, densius punctato, clypei margine antico sinuato, angulis anticis late rotundatis; antennarum flabello in utroque sexu minuto; prothorace longitudine plus duplo latiore, medio rotundato-dilatato, lateribus integris, angulis anticis fere rectangulis, parum productis, angulis posticis subrotundatis, dorso sat remote subtiliter punctato; scutello sparsissime punctulato; elytris leviter costatis, costis fere laevibus, interstitiis umbilicato-punctatis; pygidio sparsim punctato, punctis minutissime setosis. Pectore, medio glabro excepto, flavo-piloso, abdominis lateribus pilis vestitis, articulis duobus primis tarsorum posticorum longitudine aequalibus unguibus dente mediano armatis, dente ad basim dilatatam versus inclinato. Long. 21 ad 23 mm.

LUZON, Mount Banahao (*Boettcher*) IV.–V. 1914.

Holotrichia bakeri sp. nov.

H. monticolae Mos. similis, paulo major, antennarum flabello longiore. Fusca, supra subopaca, subtus nitida, abdominis lateribus pruinosis. Capite, fronte parce, clypeo subrugoso punctato, clypeo antrorsum haud angustato, margine antico reflexo, leviter sinuato, angulis anticis rotundatis; antennis rufo-fuscis, flabello maris articulis 6 praecedentibus compositis longitudine aequali, flabello feminae breviore; prothorace transverso, medio rotundato-dilatato, lateribus ante medium leviter sinuatis, angulis anticis fere rectangulis, angulis posticis rotundatis, dorso subtiliter punctato, margine postico longe flavo-ciliato; scutello juxta latera punctis nonnullis minutis instructo; elytris subrugoso-punctatis, singulis tricostatis, costis sparsissime punctatis, costa tertia indistincta; pygidio sat remote punctato. Subtus pectore longe et dense flavo-piloso, abdomine medio sparsissime, juxta latera paulo densius punctato, punctis pilis vestitis; tibiis anticis tridentatis, tarsis posticis articulo primo secundo paulo breviore, unguibus basi dilatatis et dente mediano armatis. Long. 21 mm.

LUZON, Mountain Province, Baguio (*Baker*).

Microtrichia mindanaoensis sp. nov.

♂. *M. cribripenni* Brsk. simillima, differt tarsis posticis articulo primo secundo breviore. Nigro-fusca, nitida. Capite dense punctato, clypeo brevi, margine reflexo, medio sinuato; antennis ferrugineis, 10-articulatis, flabello maris rufo-flavo, articulis 6 praecedentibus conjunctis longitudine aequali; prothorace transverso, medio rotundato-dilatato, lateribus in parte anteriore leviter crenulatis, angulis anticis paulo productis, fere rectangulis, angulis posticis obtusis, dorso sat crebre irregulariter punctato; scutello, basi excepto, punctato; elytris rugoso-punctatis, singulis indistincte quadricostatis; pygidio subrugoso, annulato-punctato, margine antico opaco. Subtus minus dense punctata, medio nitido, lateribus opacis, punctis juxta pectoris abdominisque latera et segmento penultimo brevissime setosis; tibiis anticis distincte tridentatis, unguibus late fissis. Long. 12 mm.

MINDANAO, Surigao Province, Surigao (*Boettcher*) 12. V. 1915.

Hoplia bakeri Mos., Stett. Ent. Zeit. (1921) 16.

The length of this species is 6 millimeters, not 16.

Hoplia luzonica sp. nov.

H. maculifera Mos. similis, minor, prothorace ante medium minus angustato. Picea, supra dense fusco-squamulata, elytris post medium utrinque macula obscura ornatis, subtus argenteo-squamosa, pedes rufo-fusci. Variat: Corpore supra et subtus crebre argenteo-squamulato, prothoracis vittis duabus mediis elytrorumque fasciis duabus transversis reductis obscurioribus. Capite, fronte dense squamosa, parce setosa, clypeo nitida, antrorsum angustato margine antico elevato, truncato; antennis piceis, 9-articulatis; prothorace latiore quam longiore, lateribus setosis, post medium profunda sinuatis, ante medium subsinuatis, angulis anticis rectangulis, angulis posticis obtusis, dorso squamis circularibus dense vestito et sparsim erecte setoso; elytris confertim squamosis, seriatim setosis; pygidio corporeque infra crebre squamis obtectis, illo sparsim erecte setoso; tibiis anticis tridentatis, unguibus omnibus fissis. Long. 4 ad 5 mm.

LUZON, Mountain Province, Baguio (*Boettcher*) III. 1917.

Hoplia griseovestita sp. nov.

♂. *H. simplici* Sharp similis, minor, elytrorum setis erectis minus crassis. Ferruginea, supra et subtus griseo-squamosa.

Capite, fronte dense squamulato et sparsim setosa, clypeo nitida, margine antico elevato, subsinuato; antennis fulvis, 9-articulatis; prothorace latiore quam longiore, antice et postice attenuato, angulis anticis fere rectangulis, angulis posticis obtusis, dorso dense squamoso, erecte setoso; elytris crebre squamis orbicularibus vestitis, setis parvis suberectis seriatim positis; pygidio confertim squamoso et sparsim setoso. Corpore infra dense squamulato, pedibus ferrugineis, minus crebre squamosis; tibiis anticis tridentatis, unguibus omnibus apice fissis. Long. 4 ad 5 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

A MONOGRAPH OF THE PACHYRRHYNCHID GROUP OF THE BRACHYDERINÆ, CURCULIONIDÆ: PART II[1]

THE GENERA EUPACHYRRHYNCHUS, MACROCYRTUS, EUMACROCYRTUS, APOCYRTUS, PROAPOCYRTUS, PSEUDAPOCYRTUS, NOTHAPOCYRTUS, AND EXNOTHAPOCYRTUS

By W. SCHULTZE

Entomologist, Bureau of Science, Manila

TWO PLATES

The genera treated in this part are endemic to the Philippines and are confined to a few islands of this Archipelago. The recognition of the sex of the species of these genera is of great importance for determination. For that reason I have deemed it advisable to give, on Plate 2, a representative series of lateral views of species, showing plainly the diversity in form and scale markings in both sexes in the respective species. Since the hind femora, in respect to their relative position to the apex of the elytra, offer also a very useful criterion for sex determination, they are included in the drawings in their exact position. All lateral-view drawings on Plate 2 were made with a Zeiss binocular microscope (oculars No. 1, objectives F–55) and a camera lucida. Then the drawings were reduced by means of a pantograph to one-fourth of the original size. The drawings were then completed with India ink and crayon pencil and assembled on bristol board. This plate was reproduced by means of the half-tone photo-engraving process and reduced to the present size, which is approximately twice the natural size.

Genus **EUPACHYRRHYNCHUS** Heller

Eupachyrrhynchus HELLER, Philip. Journn. Sci. § D 7 (1912) 324.

Rostrum as in *Pachyrrhynchus*, dorsoapically swollen. Scape of antennæ reaching posteriorly to posterior margin of eye. Elytra short-ovate, laterally broadened, dorsally depressed, posterior decline abrupt, particularly in the female, the apical part slightly projecting.

[1] For Part I see Philip. Journn. Sci. 23 (1923) 609–673 and 24 (1924) 309–366.

This genus forms a link between *Pachyrrhynchus* and *Macrocyrtus* (subgenus *Exmacrocyrtus* novum). The prothorax laterally only with a fine anterior submarginal groove. Anterior ventral margin of prothorax distinctly emarginate. First and second abdominal sternites connate.

Type species, *Eupachyrrhynchus superbus* Heller, from the Philippine Islands.

Eupachyrrhynchus superbus Heller.

Eupachyrrhynchus superbus HELLER, Philip. Journ. Sci. § D 7 (1912) 325, pl. 2, fig. 8.

Blackish purplish, with large scale spots which are light greenish in the central part but reddish golden around the margin. Rostrum dorsally with an oblong golden scale spot. Front between eyes fine and scatteredly punctured, in the middle with a punctiform impression. Vertex smooth. Prothorax hardly broader than long, very finely and scatteredly punctured, the greatest width before the middle. A transverse golden scale spot dorsolaterally at anterior margin, more or less confluent with a scale marking at lateral margin. Another wedge-shaped scale spot, dorsolaterally extending from the middle to the posterior margin. Elytra short-ovate, depressed, in the male posteriorly strongly declined, in the female the apical part projecting, basal half regularly striate-punctate, apical half irregularly punctate. The scaled areas of elytra larger than the bare areas, the former consisting of a golden lateral marginal stripe, which is sometimes interrupted in the basal half and apically strongly broadened, and the following scale spots which are centrally light green, marginally reddish-golden. Each elytron with two large oval subsutural spots sometimes confluent, reaching posteriorly to the middle, and a large transverse spot laterally before the middle reaching from the fourth puncture row to near the lateral margin. In apical half four smaller roundish spots and at apical third an oblong bifid sutural spot. Underside and legs glossy black, the femora with a greenish or purplish sheen. Prosternum, mesosternum, and metasternum laterally with golden scale markings. Last abdominal sternite of female with a deep groove along the margin.

Length, 13.5 to 15 millimeters; width, 7 to 7.2.

Philippine Islands (*Semper*) exact locality unknown, but I suspect that this species came from northern Luzon. Of this species I have seen only the specimen in the Dresden Museum. The above description is mainly as given by Heller.

Genus **MACROCYRTUS** Heller

Macrocyrtus HELLER,[2] Philip. Journ. Sci. § D 7 (1912) 331.

Rostrum distinctly longer than broad, in transverse section almost square, confluent with front, dorsally with a fine medial groovelike depression. Scape of antenna reaching beyond hind margin of eye. Eyes slightly convex. Elytra dorsally flattened, laterally rather angulately and abruptly declined, or uniformly convex dorsolaterally. Male with the last three abdominal sternites distinctly segmented, female with only the last sternite segmented, the others connate with metasternum. Tibiæ on underside with blunt tubercles distantly apart, more pronounced on posterior tibiæ.

Type species, *Macrocyrtus nigrans* Pascoe, from Luzon, Philippine Islands.

The generic characters as outlined above had to be somewhat amplified in order to include certain species which exhibit superficially a rather heterogeneous aspect, particularly in the general form of the elytra. The first, or typical, group, which has the elytra dorsally rather strongly flattened in both sexes, I designate as subgenus *Macrocyrtus*. The species of the second group have the elytra more strongly and uniformly convex dorsolaterally, particularly in the females; the elytra of the males dorsally more or less strongly convex or slightly flattened. The second group I designate as subgenus *Exmacrocyrtus* novum, to be typified by the species *M. erosus* Pascoe.

Subgenus **Macrocyrtus** sensu stricto

The subgenus *Macrocyrtus* s. str. contains the following species: *M. nigrans* Pascoe, *M. castaneus* Pascoe, *M. subcostatus* Heller, and *M. benguetanus* Schultze.

Key to the species of the subgenus Macrocyrtus s. str. Heller.

a^1. Elytra with distinct stripes.
- b^1. Elytra with broad whitish longitudinal stripes.... **M. subcostatus** Heller.
- b^2. Elytra with bronze green scale stripes......... **M. benguetanus** Schultze.

[2] Heller's original diagnosis is as follows:

"Rostrum latitudine distincti longius, sectione transversa fere quadrata a fronte haud distinctum, dorso sulco mediano tenui. Antennarum scapus margine oculari postica superans. Oculi parum convexi. Elytra plerumque dorso depressiuscula. Sternita abdominalia primo secundoque connata, femina solum sternita tres aspectabilia. Tibiae posticae margine interno remote tuberculatae."

a[2]. Elytra uniformly colored, without distinct stripes.

c[1]. Uniform dark brown, almost black, lateral decline of elytra very abrupt .... **M. nigrans** Pascoe.

c[2]. Castaneous brown, lateral decline of elytra not abrupt, but rounded. **M. castaneus** Pascoe.

Macrocyrtus (Macrocyrtus) nigrans Pascoe. Plate 1, fig. 3, ♀; Plate 2, fig. 3, ♂, fig. 4, ♀ (lateral view).

Apocyrtus nigrans PASCOE, Cist. Ent. 2 (1881) 593.
Apocyrtus contractus CHEVROLAT, Le Natur. 3 (1881) 363.
Macrocyrtus nigrans PASCOE, Heller, Philip. Journ. Sci. § D 7 (1912) 331, pl. 1, figs. 3, 3*a*.
Macrocyrtus nigrans var. *castanopterus* HELLER, loc. cit.

Very dark brown, almost black. Rostrum longer than broad, dorsally flattish and in a plane with front, rather densely and irregularly punctured, with a fine medial groove extending to latter. Prothorax subcylindrical, finely punctured, the punctures dorsally more or less confluent. Traces of an anterior submarginal groove faintly indicated, the posterior submarginal groove somewhat more strongly pronounced. Elytra oblong-elliptical, depressed, broadest at or slightly before the middle; laterally abruptly declined toward the margin, the apical slope very gradual and uniform; punctate-striate, the punctures rather closely approaching each other. Suture smooth and glossy. In the male abdominal sternites 1 and 2 connate, 3 to 5 well segmented; female with all abdominal sternites connate except the last, which is laterally strongly depressed, forming a triangular swelling in the middle. Hind femora in the male longer, in both sexes not reaching to apex of elytra. Penis structure, Plate 2, fig. 35.

Male, length, 14 to 15 millimeters (without rostrum); width, 5.5 to 5.8. Female, length, 14 to 16 millimeters (without rostrum); width, 5.6 to 7.3.

LUZON, Benguet Subprovince, Baguio, Irisan, mountain trail to rest house, kilometer 88 (*Curran; McGregor; Schultze*).

The general coloration and the sculpture of this species are rather variable; the color ranges from castaneous brown to almost black. In the var. *castanopterus* Heller the color is castaneous brown, the legs are reddish brown, except apex of femora and tarsi, which are black.

Macrocyrtus (Macrocyrtus) castaneus Pascoe. Plate 2, fig. 11, ♂, fig. 12, ♀ (lateral view).

Apocyrtus castaneus PASCOE, Cist. Ent. 2 (1881) 591.
Macrocyrtus castaneus PASCOE, Heller, Philip. Journ. Sci. § D 7 (1912) 331.

Castaneous brown. Very closely related to *Macrocyrtus nigrans* Pascoe. Rostrum irregularly punctured, with an indistinct medial groove reaching to front. Prothorax subcylindrical, irregularly densely punctured, beset with very minutely fine hair arising from the punctures. Some specimens with small irregular patches of creamy white hairlike scales, located dorsolaterally and at lateral margin. Elytra oblong-ovate, in the male very slender in build, much more so than in *M. nigrans*. The lateral decline of elytra not so abrupt as in the latter, but more rounded, the suture smooth and glossy, densely and irregularly striate-punctate, almost finely rugose and also beset with minutely fine hair. In the female, each elytron mostly with three faintly indicated narrow longitudinal ridges, along the lateral marginal one of which are a few scattered whitish hairlike scales. Mesosternum and metasternum laterally also with a small patch of these scales.

Male, length, 12.5 to 15.5 millimeters (without rostrum); width, 4.5 to 5.5. Female, length, 14.3 to 14.6 millimeters (without rostrum); width, 5.6 to 6.

LUZON, Benguet Subprovince, Mount Santo Tomas (*Schultze*); Mount Pulog (*McGregor; Curran*).

In this species the sculpture is also very variable. The species seems to be confined to the higher mountain ranges of Benguet Subprovince.

Macrocyrtus (Macrocyrtus) subcostatus Heller. Plate 1, fig. 2, ♂.

Macrocyrtus subcostatus HELLER, Philip. Journ. Sci. § D 7 (1912) 332, pl. 2, fig. 5; SCHULTZE, Philip. Journ. Sci. 21 (1922) 594, pl. 4, fig. 19.

Piceous; prothorax and elytra with grayish white markings formed by short scalelike hair. Rostrum longer than broad, coarsely and confluently punctured toward apex, the punctures smaller and scarcer toward base and front. An oblong longitudinal shallow depression on rostrum continued as a medial groove to front. Antennæ relatively much longer than in *Macrocyrtus nigrans* Pascoe. Prothorax longer than broad, the lateral margins slightly convergent toward anterior margin, densely and irregularly punctured and beset with fine whitish scalelike hairs, which form more or less indistinct spots dorsolaterally near anterior and posterior margins and at lateral margins. Elytra oblong-elliptical, dorsally strongly flattened, the lateral margins abruptly declined, coriaceous. Each elytron dorsally with four more or less pronounced longitudinal ridges (sutural ridge included), which become obsolete at apical fourth.

Between the ridges three broad, shallow depressions, each with two irregular rows of coarse punctures and beset with white scalelike hair, thus forming longitudinal stripes. Lateral margins also closely beset with fine white hair. Apical sutural terminations of elytra in the male evenly rounded, in female with a very small triangular excision. Legs; femora and tibiæ reddish brown, blackish near apex, tarsi also black. Underside of tibiæ setose and beset with a few small tubercles, which are more pronounced on the hind tibiæ in the male. Penis structure, Plate 2, fig. 36.

Male, length, 15.5 to 21.8 millimeters (without rostrum); width, 6 to 9. Female, length, 18 to 19 millimeters (without rostrum); width, 7.8 to 8.5.

LUZON, Benguet Subprovince, Mount Pulog (*McGregor*); Mount Santo Tomas (*Schultze*); Mount Bowdan and Mount Pulolok o (*Ramos*); Pauai (Haight's place) (*Schultze*); Suyoc (*Zschokke*).

This species is rather widely distributed in the mountain ranges of northern Luzon, but is found mostly at altitudes of about 2,000 meters.

Macrocyrtus (Macrocyrtus) benguetanus Schultze.

Macrocyrtus ? benguetanus SCHULTZE, Philip. Journ. Sci. § D 12 (1917) 255, pl. 1, fig. 8, ♀.

Macrocyrtus benguetanus var. *montanus* SCHULTZE, loc. cit., pl. 1, fig. 9, ♂.

Very dark brown; head, prothorax, and elytra with bronze green scale markings. Rostrum shagreened and irregularly punctured, fine hair arising from the punctures. A moderate, longitudinal depression, which is continued between eyes as a fine groove to vertex. The punctured areas of rostrum and front with scattered bronze green scales. Antennæ beset with fine white hair, first funicular joint the longest, second almost as long as first, the following short, each about one-third the length of second joint. Prothorax sparsely punctured, with a prominent longitudinal median groove and a rather indistinct anterior submarginal groove. Punctuation in female obsolescent. A broad bronze green dorsolateral stripe reaching from anterior to posterior margin interrupted before the middle, thus forming a roundish spot at anterior margin. Another broad stripe at lateral margins. Elytra strongly but irregularly punctate-striate. Each elytron with three irregular, longitudinal stripes, two of which are dorsolateral, the other stripe at lateral margin. These stripes are irregularly interrupted before and

behind the middle, forming irregular spots, the basal and apical spots the largest. Elytra with some fine, scattered hair, particularly at the margins apically. Legs reddish brown, finely setose. Underside of fore tibiæ with fine tubercles or blunt teeth. Apical ends of elytra of male rounded, those of female suturally acutely divergent, forming a triangular excision.

Male, length, 10 millimeters (without rostrum); width, 3.5. Female, length, 12 millimeters (without rostrum); width, 5.

LUZON, Benguet Subprovince, Mount Santo Tomas, 2,250 meters (*Schultze*).

Macrocyrtus benguetanus var. **montanus** Schultze.

Castaneous brown. Rostrum with the longitudinal depression less pronounced than in the typical form. Prothorax with the longitudinal median groove very indistinct, almost obsolete. The stripes very broad, especially on elytra. Legs red, apical half of femora and tarsi dark brown.

LUZON, Benguet Subprovince, Pauai (Haight's place), 2,700 meters, and near rest house at kilometer 88 (*Schultze*).

Subgenus **Exmacrocyrtus** novum

General form of elytra in the male oblong-oval or elliptical, more or less strongly convex; in the female the elytra broader, more convex than in the male, the apical part forming a short projection with a distinct triangular sutural excision at apex. This subgenus contains the following species: *Exmacrocyrtus erosus* Pascoe, *E. erosus* var. *impressimaculatus* var. nov., *E. pseudopolitus* Heller, *E. negrito* Heller, *E. hieroglyphicus* Schultze, *E. trivittatus* Schultze, *E. kalinganus* Schultze, *E. multipunctatus* Schultze, and *E. ilocanus* Schultze.

Key to the species of the subgenus Exmacrocyrtus novum.

a^1. With well-defined scale markings, ring markings, spots, or stripes.
- b^1. Elytra with spots or stripes.
- b^2. Elytra with white, narrow, elongate ring markings. **M. erosus** Pascoe.
  - c^1. With spots.
    - d^1. With large spots.
    - d^2. With numerous small spots .... **M. multipunctatus** Schultze.
      - e^1. With large brilliant oval spots .... **M. kalinganus** Schultze.
      - e^2. Elytra with irregular pale greenish white spots. **M. ilocanus** Schultze.
  - c^2. With stripes.
    - f^1. Elytra with six regular longitudinal stripes. **M. trivitattus** Schultze.
    - f^2. Elytra with eight more or less wavy stripes. **M. hieroglyphicus** Schultze.

a^2. With ill-defined scale markings or without any.

g^1. Elytra with or without some bluish or greenish marbled scale patches. **M. negrito** Heller.

g^2. Glossy black, elytra near apex with a few rudimentary greenish scales. **M. pseudopolitus** Heller.

g^3. Glossy black, elytra with slightly impressed grayish rudimentary spots, sometimes only traces............ **M. erosus var. impressimaculatus nov.**

Macrocyrtus (Exmacrocyrtus) erosus Pascoe. Plate 1, fig. 6, ♀; Plate 2, fig. 1, ♂, fig. 2, ♀ (lateral view).

Apocyrtus erosus PASCOE,[3] Journ. Linn. Soc. London 11 (1873) 156.
Pachyrrhynchus impressipennis CHEVROLAT, Le Natur. 3 (1881) 348.
Macrocyrtus erosus HELLER, Philip. Journ. Sci. § D 7 (1912) 331; SCHULTZE, Cat. Philip. Col. (1915) 135; Philip. Journ. Sci. 21 (1922) 593, pl. 4, fig. 18.

Glossy black, elytra with variable narrow, white scale-stripe markings forming shorter or longer oblong loops. Rostrum sparsely and irregularly punctured, with an oblong medial depression and a fine medial groove reaching to the front, at the base an indistinct transverse depression. Prothorax subcylindrical, longer than broad, finely and scatteredly punctate, with an indistinct anterior groove and a distinct posterior submarginal groove. Along anterior margin and at lateral margin some irregularly scattered scales. Elytra in the male oblong-ovate, uniformly sloping toward apex, apical sutural terminations evenly rounded; in the female broad-ovate, at apical fourth rather abruptly sloping, the apical part forming a short projection, the apical sutural terminations of elytra with a triangular excision. Elytra in both sexes striate-punctate and with shorter or longer oblong narrow white scale stripes forming loops, located in shallow groovelike depressions. These markings vary individually; in some instances they extend from near base to apical slope; in others they are interrupted, forming longitudinal series of shorter or longer ring markings. The

[3] The original Pascoe description, which seems to refer to a small male, is as follows:

"Apocyrtus erosus A. niger, nitidissimus, subtus et in capite prothoraceque fere omnino glaber; rostro supra haud excavato, in medio longitudinaliter sulcato, sulco transverso obsoleto; prothorace subcylindrico; elytris ad latera paulo ampliatis, annulis impressis (circa 20) plerisque oblongis, albo-squamulosis; pedibus validis, tibiis posticis intus fortiter denticulatis.

"Long. 6 lin.

"Hab. Luzon.

"The delicate rings on the elytra, from the fineness of the scales, have the appearance of being worm-eaten."

tubercles on underside of tibiæ more strongly pronounced on hind tibiæ, particularly in the male. Penis structure, Plate 2, fig. 38.

Male, length, 12 to 16 millimeters (without rostrum); width, 5 to 6.8. Female, length, 14 to 16 millimeters (without rostrum); width, 7 to 7.5.

LUZON, Benguet Subprovince, Baguio, Trinidad (*McGregor; Schultze; Taylor*).

This species is very common around Baguio at 1,600 meters altitude; I examined hundreds of specimens which show very great variation in the peculiar markings. At higher altitudes this species seems to be replaced by a rather characteristic form which I designate as:

Macrocyrtus (Exmacrocyrtus) erosus var. impressimaculatus var. nov.

Elytra with the puncture rows almost obliterated, the markings reduced, forming shorter or longer oblong or roundish impressed scale spots. The latter very much reduced in the male, in some instances almost absent.

LUZON, Benguet Subprovince, Mount Santo Tomas, 2,200 meters (*Schultze*); Mount Data, 2,300 meters (*Ramos*).

Macrocyrtus (Exmacrocyrtus) pseudopolitus Heller.

Macrocyrtus pseudopolitus HELLER, Philip. Journ. Sci. 19 (1921) 544.

Glossy black, nearly related to *M. erosus* Pascoe; elytra before apex with indistinct rudimentary greenish scale markings. Rostrum, dorsally irregularly punctured, with a shallow triangular depression and a medial groove reaching to the front. Prothorax longer than broad, sides very slightly rounded, subparallel, with a strongly pronounced anterior groove and a posterior submarginal groove, faintly and scatteredly punctured. Elytra short-ovate, finely and irregularly striate-punctate, subsuturally at the beginning of the abrupt posterior slope a rather prominent protuberance; apical part of elytra projecting and with a small triangular excision at the sutural termination.

Female, length, 15 millimeters (without rostrum); width, 6.5.

LUZON, Benguet Subprovince, mountain trail, near Mount Data (*Schultze*).

This species (female) in general form is most closely related to *M. erosus* Pascoe, particularly to the var. *impressimaculatus* var. nov. The only specimen before me, a female, was compared by me with the type, a female, in the Dresden Museum. It seems probable that this species is only a local form of *M.*

(*E.*) *erosus* Pascoe, but the question of its identity can be decided only after more material of both sexes has been examined.

Macrocyrtus (Exmacrocyrtus) negrito Heller. Plate 1, fig. 11, ♂.

Macrocyrtus negrito HELLER, Philip. Journ. Sci. § D 7 (1912) 333.

Black, moderately glossy, elytra with scattered bluish or greenish scales, which in some instances form irregular spots. Rostrum longer than broad, scatteredly punctured, with a medial groove, which usually extends to the front. Prothorax slightly broader than long, the lateral margins gently rounded, very finely and scatteredly punctured, with an indistinct anterior groove and a distinct posterior submarginal groove. Dorsolaterally mostly an irregular oblong scale spot and at the lateral margins a roundish patch. Elytra oblong-ovate, in the male somewhat depressed dorsally, in the female more strongly convex and toward apex more abruptly convergent, finely striate-punctate and with irregular, ill-defined squamigerous marbled patches at base, in the middle at apical third, and an interrupted marginal stripe. Mesosternum and metasternum with a scale patch laterally. Hind femora in the male with a rather prominent obtuse tooth [4] near base and four tubercles on hind tibiæ. In the female the hind tibiæ with about six very small tubercles beset with a short bristle.

Male, length, 16 millimeters (without rostrum); width, 7.8. Female, length, 17 millimeters (without rostrum); width, 8.

LUZON, Benguet Subprovince, Mount Pulog (*Curran;* type [5] specimen No. 9909 Bureau of Science collection): Kalinga Subprovince, Balbalan (*Taylor*); Bangad (*Schultze*); Davangan (*Herre*): Nueva Vizcaya Province, Santa Fe Road, near Balete rest house, about 900 meters altitude, a male and a female in copula, May 14, 1924 (*Schultze*).

This species is very variable in sculpture and scale markings and seems to have an exceptional tendency to localism. The typical forms are found near Mount Pulog. Specimens from Davangan are very glossy; in the males the scale markings form rather distinct spots; the females are uniform black. Spec-

[4] This secondary sexual character of the male is also found in the following species of the genus, although less strongly pronounced or only faintly indicated: *M. subcostatus* Heller, *M. ilocanus* Schultze, and *M. nigrans* Pascoe.

[5] The locality Baguio, as given by Heller, is erroneous.

imens from Balbalan are black in both sexes, some are very glossy, and others are very finely coriaceous.

Macrocyrtus (Exmacrocyrtus) ilocanus Schultze. Plate 1, fig. 7, ♂.

Macrocyrtus ilocanus SCHULTZE, Philip. Journ. Sci. § D 13 (1918) 372, pl. 1, fig. 10, ♀.

Glossy black, prothorax and elytra with pale greenish white scale spots. Rostrum slightly divergent toward apex. Apically finely and densely punctured, more coarsely and irregularly so toward front. A shallow triangular depression in the middle of rostrum and a well-pronounced longitudinal medial groove, the latter reaching to front. Prothorax as long as broad at base. Dorsolaterally near posterior margin an oblong spot; a fine irregular and interrupted scale line along anterior margin and a large spot at each lateral margin. Elytra finely and regularly punctate-striate. Each elytron with eight irregular pale greenish white scale spots, the spotted areas slightly depressed. Two spots at base, one, the larger, discally, the other at lateral margin; two spots at the middle, the outer one reaching almost to lateral margin; three ill-defined spots forming a cross row in apical third and one spot near apex. Between the last-mentioned spots a number of scattered scales along margin. Legs sparsely punctured and finely setose. Underside of tibiæ with a few tubercles. Penis structure, Plate 2, fig. 37.

Male, length, 16.5 millimeters (without rostrum); width, 7.5. Female, length, 16 millimeters (without rostrum); width, 8.

LUZON, Ilocos Norte Province, Mount Palimlim (*Schultze*).

Macrocyrtus (Exmacrocyrtus) hieroglyphicus Schultze.

Eupachyrrhynchus hieroglyphicus SCHULTZE, Philip. Journ. Sci. § D 12 (1917) 254, pl. 1, fig. 4, ♀.

Black, moderately glossy, prothorax and elytra with pale greenish or bluish white scale markings. Rostrum comparatively broad, strongly and confusedly punctured toward apex. A prominent squarish depression in basal half, the lateral edges of which are swollen, the depression with a fine longitudinal medial groove extending to front. Prothorax as long as broad, at base with a dorsolateral triangular spot, at middle a transverse dorsolateral spot more or less confluent with the former, and the lateral margins with a large scale spot. Elytra irregularly and indistinctly punctate-striate. Each elytron with four longitudinal more or less wavy stripes. The dorsal pair at base interrupted, forming two spots, afterward combined,

separated in the middle, forming an oblong loop, posterior of which the stripes approach each other, then separate again, forming a second loop at posterior slope. Another dorsolateral wavy stripe and a marginal stripe extend from base to apex; these two stripes run together at base, and all four stripes are confluent at apex. The striped areas very distinctly depressed. Suture and costal margin near apex with a few fine hairs. Apical sutural ends of elytra acutely divergent in the female. Legs sparsely and indistinctly punctured, finely setose, more strongly so on underside of tibiæ.

Female, length, 16.5 millimeters (without rostrum); width, 7.75. Male unknown.

LUZON, Benguet Subprovince, Baguio and Irisan River (*Schultze*).

Macrocyrtus (Exmacrocyrtus) trivittatus Schultze. Plate 1, fig. 8, ♀; Plate 2, fig. 10, ♂ (lateral view).

Macrocyrtus trivittatus SCHULTZE, Deutsche Ent. Zeitschr. (1922) 42, pl. 1, fig. 4, ♂.

Dull black, head and prothorax with pale green scale markings, elytra with longitudinal stripes. Rostrum irregularly punctured, basal half with a large shallow and roundish depression and a fine longitudinal medial groove reaching to front. A bifid scale spot at base of rostrum and front. Prothorax as long as broad, at base dorsolaterally with a triangular scale spot, which is confluent in the female with a lateral spot in the middle. Lateral margins with a large irregular spot. Elytra oblong-ovate, finely coriaceous, indistinctly punctate-striate, in the male rounded at apex, in the female the apex forming a short beak-shaped projection, the apical ends slightly divergent, forming a small triangular excision. Each elytron with three stripes, these smaller in the male, but broader in the female; one of these stripes extends dorsolaterally from base to apex where it becomes confluent with a lateral-marginal stripe. Another stripe between sixth and seventh interstices extending from near base to near apex, where it also becomes confluent with the marginal stripe. Mesosternum, metasternum, and first abdominal sternite laterally with a scale spot. Underside of tibiæ setose, more strongly so in the male. Penis structure, Plate 2, fig. 40.

Male, length, 15.5 millimeters (without rostrum); width, 6.5. Female, length, 16 millimeters (without rostrum); width, 7.

LUZON, Benguet Subprovince, Mount Pulog (*Schultze*): Nueva Vizcaya Province, Imugan (*Boettcher*).

This species has a remarkable likeness to *Pachyrrhynchus inclytus* Pascoe (= *P. modestior* Behrens).

Macrocyrtus (Exmacrocyrtus) multipunctatus Schultze. Plate 1, fig. 1, ♂; Plate 2, fig. 21, ♂ (lateral view).

Macrocyrtus multipunctatus SCHULTZE, Deutsche Ent. Zeitschr. (1922) 41.

Glossy black; head, prothorax, and elytra with light green scale markings. Rostrum twice as long as broad, the sides nearly parallel, dorsally irregularly scatteredly punctured, in the basal half with a shallow triangular depression and a strongly pronounced longitudinal medial groove extending to front. Latter finely and sparsely punctured with a bifid roundish scale spot. Sides of rostrum at base before eye with a distinct triangular depression, a small scale spot below eye. Prothorax slightly longer than broad, an irregular narrow scale band along anterior margin confluent with a large scale spot at each lateral margin, at base dorsolaterally an irregular oblong triangular scale spot. Elytra oblong-ovate, uniformly rounded at apex, finely and indistinctly punctate-striate, with a large number of scattered small roundish or oblong light green scale spots, forming irregular and indistinct transverse groups near base, in the middle, and at apical third. Mesosternum, metasternum, and first abdominal sternite with a scale patch laterally. Underside of tibiæ with four obtuse or blunt teeth, more pronounced on posterior tibiæ and sparsely setose. Penis structure, Plate 2, fig. 39.

Male, length, 14 millimeters (without rostrum); width, 6.5. Female unknown.

LUZON, Nueva Vizcaya Province, Imugan (*Boettcher*).

Macrocyrtus (Exmacrocyrtus) kalinganus Schultze. Plate 1, fig. 10, ♂; Plate 2, fig. 9, ♀ (lateral view).

Macrocyrtus kalinganus SCHULTZE, Deutsche Ent. Zeitschr. (1922) 42, pl. 1, fig. 3, ♀.

Glossy piceous (pitch brown) with a violet sheen; head, prothorax, and elytra with brilliant metallic scale spots. Rostrum scatteredly punctured with a very large and shallow depression reaching to front, almost entirely beset with a scale spot, and with a sharply defined longitudinal medial groove. Prothorax as long as broad, finely and scatteredly punctured, at base dorsolaterally a small triangular scale spot and another larger spot dorsolaterally before the middle. Lateral margins with a large oblong scale patch. Elytra irregularly and indis-

tinctly punctate-striate. Each elytron with eight scale spots and a small bifid sutural spot near apex. Five large, oval or roundish spots, two of which are at base, two in the middle, and one at apical third dorsolaterally. An elongate marginal spot extends backward from the middle, a small roundish spot is located between the latter and a triangular apical spot. Color of the scales of the spots is, in the marginal area of each spot, brilliant reddish golden, but in the central area metallic greenish or bluish. Elytra of male at apex evenly rounded, of female forming a short beaklike projection, the apical terminations slightly divergent, forming a small triangular excision. Mesosternum, metasternum, and first abdominal sternite with a scale spot laterally. Femora with a scale spot near apex. Underside of tibiæ setose, the hind tibiæ more strongly so.

Male, length, 15.2 millimeters (without rostrum); width, 6. Female, length, 16.5 millimeters (without rostrum); width, 7.5.

LUZON, Kalinga Subprovince, Balbalan (*Taylor*).

This species has the most remarkable likeness to *Pachyrrhynchus taylori* Schultze.

Genus **EUMACROCYRTUS** Schultze

Eumacrocyrtus SCHULTZE, Philip. Journ. Sci. 23 (1923) 599.

Related to *Macrocyrtus* Heller. Rostrum slightly longer than broad. Scape of antenna reaching beyond posterior margin of eye. Prothorax with distinct and sharply defined anterior and posterior submarginal groove, and a dimplelike depression dorsolaterally. Elytra dorsally slightly flattened, the greatest width in the middle, lateral margins from the middle rather abruptly and strongly convergent toward apex; apical fourth of elytra extending beyond abdomen, forming a mammilla-shaped projection in both sexes. First and second abdominal sternites in both sexes connate, the following three well segmented.

Type species, *Eumacrocyrtus canlaonensis* Schultze, from Negros, Philippine Islands.

Eumacrocyrtus canlaonensis Schultze. Plate 1, fig. 9, ♀; Plate 2, fig. 19, ♂, fig. 20, ♀ (lateral view).

Eumacrocyrtus canlaonensis SCHULTZE, Philip. Journ. Sci. 23 (1923) 599.

Dark brown, almost black, with inconspicuous pale bluish white scale markings. Rostrum dorsally scatteredly punctured, with an indistinct longitudinal groovelike depression extending to front, where it forms a well-pronounced groove; at base an

indistinct transverse depression. Prothorax as long as broad, glossy, finely and scatteredly punctured, a minute hair arising from each puncture, the punctures nearly obsolete in the male. A dimplelike depression dorsolaterally, nearer the middle than the base. At lateral margins an irregular patch of fine bluish white scales. Elytra finely, scatteredly punctured and sparsely granulate in the male, in the female the punctures much coarser and more irregular. Elytra dorsally in both sexes with very fine and evenly scattered scales. The latter toward and at basal and lateral margins gradually increase in size and density and are most strongly pronounced as an irregular broad stripe along basal and lateral margins. The apical mammillary projection slightly longer in the female, in both sexes beset with rather long scattered setæ arising from the punctures, particularly along the connate suture. Mesosternum slightly, metasternum and first and second abdominal sternites in the middle with a large and prominent patch of dense furlike ochraceous pubescence in both sexes. Legs reddish brown, femora irregularly punctured, sparsely setose. Tibiæ on underside with a number of small tubercles, moderately setose. Penis structure, Plate 2, fig. 41.

Male, length, 14.5 to 16 millimeters (without rostrum); width, 5.8 to 6.6. Female, length, 14 to 15.5 millimeters (without rostrum); width, 6 to 6.8.

NEGROS, Occidental Negros, Canlaon Volcano (*Taylor; Banks; Curran*).

Twenty specimens of this very characteristic species that I have examined show considerable variation in the punctures and sculpture of the elytra. The hind femora are slightly longer in the male than in the female.

Genus **APOCYRTUS** Erichson

Apocyrtus ERICHSON, Nov. Act. Ac. Leop. Carol. 16 (1834) Suppl. 1, 252; SCHOENHERR, Gen. Curc. 5 (1839) 824.

Rostrum dorsally slightly convex, separated at base from front by a deep and straight transverse groove. Eyes rather strongly bulging. Antenna reaching beyond hind margin of eye. Prothorax subglobular, anterior margin ventrally emarginate, at posterior margin strongly constricted. Scutellum absent. Elytra subglobularly inflated. First and second abdominal sternites in both sexes connate, the last three well segmented in the male; in the female, the third and fourth sternites suberect, more or less lamelliform, the fifth rather strongly

depressed. Hind femora in the male reaching well beyond apex of elytra, in the female only in line with the latter.

Type species, *Apocyrtus inflatus* Erichson, from Luzon, Philippine Islands.

Apocyrtus inflatus Erichson. Plate 2, fig. 5, ♂, fig. 6, ♀ (lateral view).

Apocyrtus inflatus ERICHSON, Nov. Act. Ac. Leop. Carol. **16** (1834) Suppl. 1, 254, pl. 38, fig. 8; BOHEMAN, Schoenherr. Gen. Curc. **5** (1839) 824; WATERHOUSE, Ann. & Mag. Nat. Hist. **11** (1843) 249; HELLER, Philip. Journ. Sci. § D **7** (1912) 301, pl. 1, figs. 1, 1*a*.

Head, prothorax, underside, and legs black, elytra dark reddish brown to black. Rostrum irregularly punctured, basal half with a strongly pronounced medial groove extending to front, the basal transverse groove deep. Front scatteredly punctured, and with a few scales. Prothorax subglobular, beset with large, roundish, polished, glossy tubercles, except a small anterior submarginal and posterior submarginal stripe which is smooth. Dorsally an indistinct medial groove, beset with an interrupted line of pale green scales, at each lateral margin an irregular oblong patch of pale green scales and in some specimens a few scattered scales dorsolaterally near anterior margin. Elytra strongly inflated, subspherical, apical sutural decline abrupt, in the male rounded at apex, in the female with a small triangular excision; rather coarsely sculptured, rugose, and subtuberculate in irregular rows. A small irregular scale spot near base laterally and another more triangular spot laterally near apex, along margin some irregularly scattered scales. Mesosternum and metasternum with a patch of scales laterally. In the female the third abdominal sternite with a suberect bilobed lamelliform appendage, the fourth with a flattened, triangular appendage in the middle, the fifth with a rather strong depression. Penis structure, Plate 2, fig. 27.

Male, length, 9 to 11 millimeters (without rostrum); width, 4.6 to 6. Female, length, 10 to 11.5 millimeters (without rostrum); width, 5.5 to 6.2.

LUZON, Laguna Province, Paete (*McGregor; Schultze*): Rizal Province, Montalban. POLILLO (*Schultze*).

In two specimens from Polillo, females, the sculpture appears slightly coarser; but, otherwise, I am unable to detect any appreciable differences in a comparison with a large series of this species from Luzon.

Apocyrtus mcgregori sp. nov. Plate 2, fig. 30, ♂, fig. 31, ♀.

Black with pale yellowish scale markings. Smaller, slenderer, and not so strongly inflated as *A. inflatus* Erichson. Rostrum densely and confusedly punctured, with a medial groovelike depression in basal half, the transverse basal groove strongly defined. Front slightly depressed, with a medial groove, and entirely covered by a large scale spot. Sides of head with a few scales below eye. Prothorax subglobular, as long as broad, strongly roundish granulate with an indistinct medial groove and a broad, ill-defined medial scale stripe. Dorsolaterally another ill-defined stripe more or less confluent with a large scale patch at lateral margins reaching from anterior to posterior margin. Elytra similar in form to *A. inflatus,* but not so strongly inflated, irregularly striate-punctate, the punctures dorsally very large, toward the sides confused, the interstices more or less subtuberculate. Female at the beginning of apical decline with a sutural knoblike swelling, the latter as well as the sutural region to apex beset with fine scattered setæ. Each elytron with five broad and irregular, more or less interrupted longitudinal scale stripes and an irregular abbreviated sutural stripe. The stripes are confluent at base in the male; they are broader than the bare interspaces and have a tendency to form oblong spots, particularly in the female. Underside, mesosternum, metasternum, and first abdominal sternite laterally with a scale patch. Third to fifth abdominal sternites in female lamelliform, suberect, with the hind margins evenly rounded.

Male, length, 9.3 millimeters (without rostrum); width, 3.8. Female, length, 10 millimeters (without rostrum); width, 4.7.

LUZON, Bataan Province, Lamao (*Schultze*).

This species is easily recognized on account of the peculiar stripe markings and bears a strong superficial resemblance to *Pseudapocyrtus multimaculatus Schultze.* I take pleasure in naming this species for my friend Mr. R. C. McGregor, ornithologist of the Philippine Bureau of Science.

Genus **PROAPOCYRTUS** Schultze

Proapocyrtus SCHULTZE, Philip. Journ. Sci. § D 13 (1918) 371.

Rostrum with a prominent medial groove, extending to vertex, and a strongly pronounced transverse groove before eyes. Antenna with first and second funicular joints of equal length, third to seventh also equal in length, together one-fifth longer than first and second. Prothorax subcylindrical, dorsally some-

what flattened, with an anterior and a posterior submarginal groove. Elytra dorsally flattened, laterally strongly and abruptly declined in an acute angle, apically produced, on the posterior decline with prominent subsutural ridges, and apical ends of elytra divergent. Hind femora reaching to about the third fourth of length of elytra posteriorly.

Type species, *Proapocyrtus insularis* Schultze, from Panay, Philippine Islands.

This genus is most nearly related to *Apocyrtus* Erichson, but it is easily recognizable by the oblong-oval and dorsally flattened form of the elytra, as compared with the more spherical and inflated elytra of that genus.

Proapocyrtus insularis Schultze.

Proapocyrtus insularis SCHULTZE, Philip. Journ. Sci. § D 13 (1918) 371, pl. 1, fig. 1.

Black, with pale green scale spots. Rostrum very irregularly and coarsely, front more finely, sparsely, and scatteredly punctured. The medial groove broad, on front and vertex fine and narrow. Prothorax strongly coriaceous, with an irregular medial groove. A small spot at middle laterad and another, larger spot at lateral margin. Elytra very coarsely and irregularly punctate-striate, the interstices forming raised ridges. The lateral decline of elytra with deep elongated depressions. Each elytron with eight scale spots, and one bifid spot on suture at posterior decline. The eight spots are located as follows: Two near base, the one at lateral margin the larger; four in the middle area, two of which are at disk, one at the lateral decline, the other at lateral margin; one at apical third; and one in apical triangle. Legs finely and scatteredly punctured, the tibiæ finely and sparsely setose.

Length, 15 millimeters; width, 6.5.

PANAY, Capiz Province, mountains near Jamindan: Antique Province, Culasi (*McGregor*).

The spots are somewhat variable in color; in one of the specimens from Culasi they are blue.

Genus **PSEUDAPOCYRTUS** Heller

Pseudapocyrtus HELLER, Philip. Journ. Sci. § D 7 (1912) 326.

Rostrum slightly longer than broad, convex, confluent with front, dorsally without any impression. Upper margin of

scrobe distinctly carinate. Scape of antenna reaching well beyond hind margin of eye. Eyes moderately convex. Prothorax truncate at base. Elytra convex and more or less strongly inflated. First and second abdominal sternites in both sexes connate, in the female the third sternite not with a suberect lamelliform appendage.

Type species, *Pseudapocyrtus imitator* Heller, from Luzon, Philippine Islands.

This genus is very nearly related to *Apocyrtus* Erichson, but the latter is readily distinguished by the strongly pronounced and straight transverse basal groove of rostrum, which in *Pseudapocyrtus* is almost obsolete and more or less V-shaped. Certain species included in the genus *Pseudapocyrtus* have rather a heterogeneous aspect from the typical species *P. imitator* Heller, on account of the difference in the form of the prothorax, which in the latter is subcylindrical and in others, such as *P. formicarius* Heller, subglobular. In view of the fact that the other characters agree fairly well, it seems better to retain them in this genus for the present.

Key to species of Pseudapocyrtus Heller.

a^1. Prothorax subcylindrical, longer than broad.
  b^1. Elytra dorsally without any distinct longitudinal ridges.
  b^2. Elytra dorsally with distinct ridges and pale blue scale spots.
    P. imitator Heller.
    c^1. Elytra irregularly striate-punctate, the punctures not confluent, and with creamy white scale spots .... **P. apicatus** Schultze.
    c^2. Elytra coarsely and confusedly striate-punctate, punctures larger than the irregularly confluent interstices..... **P. productus** Heller.
a^2. Prothorax subglobular.
  d^1. General color black, elytra with ring markings or well-defined spots.
    e^1. Elytra with pale flesh colored scale ring spots.
      P. schadenbergi Heller.
    e^2. Elytra with numerous but well-defined pale green scale spots.
      P. multimaculatus Schultze.
  d^2. General color not black.
    f^1. Prothorax red, elytra black.
    f^2. Prothorax black, elytra reddish brown, the latter before apex at lateral margins with a deep curved excision.
      P. exsectus Heller.
      g^1. Prothorax dorsally red, relatively larger than in the following species; apical prolongation of elytra less strongly pronounced.
        P. formicarius Heller.
      g^2. Prothorax relatively smaller than in *P. formicarius;* apical prolongation of elytra longer and more strongly pronounced than in the latter .... **P. catanduanensis** Schultze.

Pseudapocyrtus imitator Heller. Plate 2, fig. 17, ♂, fig. 18, ♀ (lateral view).

Pseudapocyrtus imitator HELLER, Philip. Journ. Sci. § D 7 (1912) 329, pl. 1, figs. 2, 2*a*; pl. 2, fig. 2.

Black, elytra dark reddish brown with pale bluish scale markings. Rostrum scatteredly and finely punctured, separated by a fine V-shaped groove from front, the latter with an abbreviated medial groove and sparsely punctured. Antenna reddish brown. Prothorax subcylindrical, longer than broad, the greatest width in the middle, dorsally flattish granulate with an indistinct medial groove, beset with a narrow and irregular stripe of scales, lateral margins with a large blue scale patch. Elytra subglobular, the apical part laterally constricted, forming an apically rounded prolongation, coarsely striate-punctate, the interstices forming distinct ridges dorsally, at sides the sculpture more confused. Each elytron with a scale spot in the middle at base, another near the latter and the margin, in the middle a transverse row of about three spots, an oblong marginal spot slightly behind the middle, two dorsolateral spots at apical third and another spot near apex, some specimens with a sutural spot at apical decline. Underside glossy black, mesosternum and metasternum with a scale spot laterally. Legs red, except apical part of femora, which is black.

Male, length, 9 millimeters (without rostrum); width, 4.5. Female, length, 9 to 10 millimeters (without rostrum); width, 4.8 to 5.

LUZON, Benguet Subprovince, Irisan (*McGregor*); Baguio, Mount Santo Tomas (*Schultze*).

Pseudapocyrtus apicatus Schultze. Plate 2, fig. 26, ♀.

Pseudapocyrtus apicatus SCHULTZE, Philip. Journ. Sci. 21 (1922) 581, pl. 1, fig. 7, ♀.

Head, prothorax, and legs black, elytra castaneous brown with cream colored scale spots. Related to *P. imitator* Heller. Rostrum dorsally slightly convex, densely punctured, at base separated from front by a curved transverse groove. Front scatteredly punctured, with a medial groove and a scale spot. Prothorax subcylindrical, longer than broad, coarsely and transversely rugose with an indistinct longitudinal medial groove. Dorsolaterally a not very densely scaled stripe reaching from anterior to posterior margin, and another broader

stripe at lateral margins. Elytra moderately glossy, irregularly striate-punctate. Each elytron with seven large scale spots, one at base, five in the middle part, two of which are located at lateral margin, and a large triangular spot at apical projection. The projection at lateral margin apically with a small curved excision, the sutural ends curved downward, resembling a beak in shape. Mesosternum and metasternum laterally with a scale spot. Last abdominal sternite with a curved excision. Hind femora not reaching beyond elytra.

Female, length, 10.5 millimeters (without rostrum); width, 4.5.

LUZON, Bontoc Subprovince (*Schultze*).

Pseudapocyrtus productus Heller.

Pseudapocyrtus productus HELLER, Philip. Journ. Sci. § D 7 (1912) 330.

Black; elytra reddish yellowish brown to castaneous, sides blackish, with a greenish scale spot at base and two at lateral margins. Rostrum finely punctured, front with an anteriorly forked medial groove. Prothorax subcylindrical, slightly longer than broad, polished off granulate, lateral margins with some greenish scales. Elytra coarsely and confusedly striate-punctate, the punctures larger than the irregularly confluent interstices. Sides of elytra from base to middle nearly straight but divergent, then roundish inflated, the apical part forming a beak-shaped projection, each elytron at apex with a small knob, the lateral margins at apex with a short and small emargination in the female, in the male with a small sutural knob behind second third. At base a small transverse scale spot, another oblong spot at lateral margin anteriorly, and a stripelike greenish scale spot posteriorly. Mesosternum and metasternum with a scale patch laterally. Legs, with the exception of the black apical parts of femora, reddish. Hind femora not reaching beyond apex of elytra (♀ !, ♂ ?).

Length, 12 to 13 millimeters; width, 6 to 6.5.

Philippine Islands, exact locality unknown (*Semper*).

This species I know only from the original description. The statement in the last sentence concerning the hind femora, as given by Heller, seems strange to me, since in the species of this genus known to me the hind femora of the males do extend beyond apex of elytra.

Pseudapocyrtus schadenbergi Heller. Plate 2, fig. 22, ♀ (lateral view).

Pseudapocyrtus schadenbergi HELLER, Philip. Journ. Sci. § D 7 (1912) 327, pl. 2, fig. 3.

Black, moderately glossy, in general body form similar to *A. inflatus* Erichson; scale markings on prothorax pale green, scale-ring spots on elytra pale flesh colored. Rostrum scatteredly punctured with an indistinct medial groove, which forms a punctiform depression at base and becomes obsolete at front. Prothorax subglobular, with an ill-defined anterior and a well-defined posterior submarginal groove, only the marginal areas smooth, otherwise coarsely granulate but polished off. Dorsolaterally an irregular scale patch, and another at lateral margin. Elytra short-ovate, apical fourth laterally depressed, forming a nasutiform projection, very coarsely striate-punctate, the punctures somewhat irregular toward lateral margins. Each elytron with about thirteen roundish scale spots, the center part of most of which is bare. Four spots are located at basal fourth, three spots form a transverse row at about the middle, one elongate marginal spot behind the middle, and five spots and a large bifid sutural spot are located at apical third. Mesosternum, metasternum, and first abdominal sternite laterally with a scale spot. Abdominal sternites rugose and, except the first and the last, connate. Hind femora not reaching apex of elytra in the female, but extending well beyond in the male.

Male, length, 10 millimeters (without rostrum); width, 5. Female, length, 12 millimeters (without rostrum); width, 5.7.

LUZON (*Schadenberg*); Ilocos Norte Province, Mount Palimlim (*Schultze*).

Heller's type specimen is undoubtedly a male, since he mentions the hind femora extending beyond the apex of the elytra.

Pseudapocyrtus multimaculatus Schultze.

Pseudapocyrtus multimaculatus SCHULTZE, Philip. Journ. Sci. § D 13 (1918) 372, pl. 1, fig. 2.

Glossy black, with pale green spots. Rostrum densely and irregularly punctured. A prominent medial groove from base of rostrum reaching to vertex. A large scale spot on front. Prothorax as long as broad, strongly coriaceous. A prominent medial groove, beset with scales, laterad of which a broad irregular scale stripe, another at lateral margin. Elytra shiny, irregularly punctate-striate, the punctures very coarse. The interstices forming slightly elevated ridges or callosities. Spot-

ted areas depressed. Basal area with a series of six irregular pale green scale spots. At the middle, forming a cross row, a series of four spots, and in apical third a series of five, slightly larger spots. A lateral-marginal stripe extending from base to second third only. In posterior half a subsutural series of spots, forming an interrupted stripe which terminates near apex. Underside with a spot laterally at mesosternum and metasternum, and the visible parts of abdominal sternites. Legs finely and sparsely punctured, rugose, and finely setose.

Length, 12 millimeters; width, 5.5.

LUZON, Ilocos Norte Province, Mount Palimlim (*Duyag*).

Pseudapocyrtus exsectus Heller.

Pseudapocyrtus exsectus HELLER, Philip. Journ. Sci. § D 7 (1912) 328, pl. 1, fig. 25 (elytra, lateral view).

Black; elytra, middle part of femora, tibiæ and tarsi reddish brown. More similar to *Apocyrtus inflatus* than to *Pseudapocyrtus imitator* Heller, slightly larger than both. Rostrum slightly conically obtuse, moderately densely and finely punctured. Antennæ as in *P. imitator*, front with an oblong greenish scale spot. Prothorax subglobular, slightly broader than long, the greatest width somewhat nearer the base, netlike strongly polished off granulate, with a few impressed punctures and a narrow medial stripe of greenish scales. Elytra subglobular, coarsely irregularly striate-punctate, the punctures more or less confused and confluent. Lateral margins near apex with an elongate curved excision, above which is located an elongate greenish scale spot. Lateral margins of prothorax, mesosternum, and metasternum laterally with some scattered greenish scales.

Female, length, 11.5 millimeters (without rostrum); width, 6.5.

Philippine Islands, exact locality unknown (Dresden Museum, ex coll. Kirsch).

This species I know only from the description.

Pseudapocyrtus formicarius Heller. Plate 2, fig. 13, ♂, fig. 14, ♀ (lateral view).

Pseudapocyrtus formicarius HELLER, Philip. Journ. Sci. § D 7 (1912) 327, pl. 2, fig. 1; SCHULTZE, Philip. Journ. Sci. 21 (1922) 583.

Black; prothorax dorsally, antennal scape, and femora, except basal and apical parts, red. Rostrum moderately densely and finely punctured. Front between eyes with a punctiform

impression. First funicular joint slightly longer than the elongate second, third elliptical, the following globular, gaining in size toward club, the latter longer than the five preceding funicular joints together. Prothorax subspherical, very slightly longer than broad, dorsally red and polished off granulate with a fine medial groove and an anterior and a posterior submarginal groove. The narrow anterior marginal area also black and distinctly swollen. The red color dorsally changes to black at lateral margins, where the granulation also becomes obsolete and where a few scattered pale greenish scales are located. Elytra subglobular, strongly inflated, laterally the apical fifth depressed, forming in the male a short prolongation rounded at apex, in the female the prolongation more pronounced, more acute at apex, the apical sutural termination with a curved excision and another curved excision laterally, so that each elytron ends in an acute toothlike point. Elytra very regularly striate-punctate, the punctures very coarse, at sides some distantly scattered pale greenish or bluish scales. First and second abdominal sternites in the female connate, the apparently third sternite retracted but flat, at apex with an oblong excision. Hind femora in the female reaching to apex of elytra, in the male well beyond. The penis structure, Plate 2, fig. 28, shows clearly the approximate relation of this species to *A. inflatus* Erichson, and in a still stronger degree to *P. catanduanensis* Schultze.

Male, length, 9 millimeters (without rostrum); width, 4.5. Female, length, 10.8 to 11.6 millimeters (without rostrum); width, 5.5 to 6.

POLILLO (*McGregor; my collector*).

The type locality "Luzon orientalis;" (Dr. C. Semper and J. Whitehead) seems doubtful to me.

Pseudapocyrtus catanduanensis Schultze. Plate 2, fig. 23, ♂, fig. 24, ♀ (lateral view).

Pseudapocyrtus catanduanensis SCHULTZE, Philip. Journ. Sci. 21 (1922) 582, pl. 2, fig. 7, ♀ (pl. 7, fig. 12, penis structure).

Black; scape of antenna, prothorax dorsally, and legs red, except apical part of femora and tibiæ and the tarsi, which are also black. Nearly related to *P. formicarius* Heller. Rostrum finely and scatteredly punctured, in basal half with a sharply defined medial groove terminating at the beginning of the front in a punctiform impression. Prothorax subspherical, as long as broad, polished off granulate with a well-pronounced medial

groove and an anterior and a posterior submarginal groove. The submarginal areas also black and swollen. Prothorax relatively smaller than in *P. formicarius.* Elytra in the male one and one-fifth times as long as broad, strongly inflated, subglobular or short-ovate, near apex laterally slightly depressed, at apex rounded; in the female one and one-half times as long as broad, apical third laterally strongly depressed, forming a nasutiform prolongation. Apical termination of elytra as in *P. formicarius,* but more pronounced. Sculpture of elytra also as in the latter, but coarser, also some sparsely scattered scales at sides. Hind femora in the female not reaching to apex of elytra, in the male well beyond. Penis structure, Plate 2, fig. 29.

Male, length, 9.5 to 10 millimeters (without rostrum) ; width, 4.5 to 4.7. Female, length, 11 to 12 millimeters (without rostrum) ; width, 5 to 5.7.

CATANDUANES, Virac (*Schultze*).

Genus **NOTHAPOCYRTUS** Heller

Nothapocyrtus HELLER, Philip. Journ. Sci. § D 7 (1912) 334.

Rostrum longer than broad, with a broad shallow longitudinal dorsal groovelike depression reaching to front. Eyes relatively large, moderately convex. Scape of antennæ reaching posteriorly slightly beyond anterior margin of prothorax. The latter subcylindrical, longer than broad. Elytra spindle-shaped, but truncate at base, basal margin not carinate. The last three abdominal sternites in both sexes not connate, anal sternite in female swollen in the middle and depressed laterally. Hind femora of female reaching to apex of elytra, but in male reaching well beyond.

Type species, *Nothapocyrtus translucidus* Heller, from Luzon, Philippine Islands.

Heller founded this genus on a supposedly female specimen of *N. translucidus* but, from his description, "Decken, und die diese deutlich überragenden Hinterschenkel," it seems certain this is a mistake, since it is only in the male that the femora extend distinctly beyond the apex of the elytra. Furthermore, he included in this genus, provisionally, two other rather heterogeneous species, *N. cylindricollis* and *N. erythromerus* Heller. These two species, as well as all other species described up to the present as belonging to the above genus, must be placed in a new genus.

Nothapocyrtus translucidus Heller. Plate 1, fig. 4, ♀; Plate 2, fig. 7, ♂, fig. 8, ♀ (lateral view).

Nothapocyrtus translucidus HELLER, Philip. Journ. Sci. § D 7 (1912) 335.

Black; elytra light reddish brown or castaneous brown except a basal and a lateral marginal stripe and the apical area, which are black. Rostrum scatteredly and rather coarsely punctured, longer than broad, a broad longitudinal depression, extending to front, laterally set off by indistinct ridges, the latter of which are slightly convergent toward base. Prothorax glossy, coarsely and scatteredly punctured, sides slightly convergent toward anterior margin, dorsolaterally an ill-defined abbreviated longitudinal stripe of blue scales, extending from base to about middle. Another irregular scale patch at lateral margin. Elytra striate-punctate, the punctures rather coarse, finely and sparsely setose near apex. Each elytron with a small blue scale spot near apex. Apical termination of elytra in the female in lateral view more strongly curved, beaklike. Underside glossy black. Mesosternum and metasternum laterally with a patch of blue scales. Legs sparsely and finely whitish setose. Penis structure, Plate 2, fig. 34.

Male, length, 6.8 millimeters (with rostrum); width, 2.5. Female, length, 7.2 millimeters (with rostrum); width, 2.8.

LUZON, Benguet Subprovince, Mount Santo Tomas (*Schultze*); Cabayan (*McGregor*).

Heller's type is undoubtedly a rather young specimen, not fully hardened, since in fresh specimens the color of the elytra is reddish yellowish brown; it becomes darker castaneous brown in fully developed specimens.

Genus **EXNOTHAPOCYRTUS** novum

Rostrum longer than broad, divergent toward apex, dorsally with a very broad but shallow depression and an indistinct medial groove, the dorsolateral margins swollen. Front with a punctiform impression, from which extends an almost obsolete groove obliquely to anterior margin of eyes. Prothorax subcylindrical, longer than broad. Elytra oblong-oval, truncate at base, in the female dorsally slightly flattened, and at apex with a triangular sutural excision. Elytra of the male at apex broadly rounded, the posterior slope more abrupt. Hind femora in the female extending up to, or slightly beyond, apex of elytra; in the male well beyond.

Type species, *Exnothapocyrtus cylindricollis* Heller, from Luzon.

The species of this genus were formerly placed in the genus *Nothapocyrtus* Heller; but, on account of the different general body shape and the much larger size, their status in that genus cannot be retained.

Key to species of Exnothapocyrtus g. nov.

*a*¹. Elytra with pale green or white scale markings.
  *b*¹. Elytra without fine, scattered, white hair.
  *b*². Elytra with fine, scattered, white hair, at lateral margin two scale spots .... **E. erythromerus** Heller.
    *c*¹. Elytra with eighteen to twenty moderately sized pale greenish white scale spots .... **E. cylindricollis** Heller.
    *c*². Elytra with twelve large white scale spots. **E. alboplagiatus** Heller.
*a*². Elytra with blue scale markings.
  *d*¹. Each elytron with four well-defined spots; two at base, one at lateral margin, one near apex .... **E. luzonicus** Schultze.
  *d*². Elytra with irregular transverse scale band at base and middle, two spots at margin, one spot near apex .... **E. basifasciatus** Heller.

Exnothapocyrtus cylindricollis Heller. Plate 2, fig. 15, ♂, fig. 16, ♀ (lateral view).

Nothapocyrtus cylindricollis HELLER, Philip. Journn. Sci. § D 7 (1912) 336, pl. 2, fig. 6, ♂.
Nothapocyrtus chloropunctatus HELLER, Deutsche Ent. Zeitschr. (1916) 282.

Dark castaneous brown to almost black, glossy, with pale greenish white or bluish white scale spots. Rostrum longer than broad, divergent toward apex, dorsally with a large oblong shallow depression and an indistinct medial groove. Apical half, as well as toward lateral margins, irregularly punctured and very finely setose. Prothorax slightly longer than broad, subcylindrical, near anterior margin very moderately convergent, finely and scatteredly punctured. Dorsolaterally in the middle, toward each side, a small scale spot mostly smaller than eye and at lateral margins a large oblong scale patch. Elytra oval, dorsally moderately flattened in the female, slenderer and dorsally more convex in the male, apical area black, with an indistinct transverse constriction in both sexes, with regular rows of fine punctures. Each elytron mostly with nine or ten scale spots placed as follows: Two spots at base, three spots form an oblique transverse row before the middle, three or four spots form an irregular transverse row at apical third, the lateral

marginal spot of which is the largest, and a more or less triangular spot near apex. Mesosternum and metasternum with a scale spot laterally. Last three abdominal sternites in both sexes not connate. Penis structure, Plate 2, fig. 32.

Male, length, 9.2 to 10.6 millimeters (with rostrum); width, 3.5 to 3.8. Female, length, 11.6 millimeters (with rostrum); width, 4.

LUZON, Benguet Subprovince, Baguio, Mount Mirador (*Schultze*).

Heller's description of *Nothapocyrtus cylindricollis* is based on a single male, and of *N. chloropunctatus* on a single female specimen.

This species is rather variable with reference to the scale markings. Among numerous specimens examined several were found in which the spots were almost absent, or only represented by faint traces, and the dorsolateral spots on the prothorax are sometimes elongated, forming an interrupted stripe.

Exnothapocyrtus alboplagiatus Heller.

Nothapocyrtus alboplagiatus HELLER, Deutsche Ent. Zeitschr. (1916) 281.

Black; head, prothorax, and elytra with chalk white scale markings. Rostrum distinctly longer than broad, toward apex slightly divergent, dorsally with a broad and shallow concave depression, scatteredly punctured. Front with an elongate scale spot. Scape of antenna reaching slightly beyond anterior margin of prothorax. The latter as long as broad at base, quite conical, dorsally very finely shagreened, discally with some irregularly scattered coarse punctures and with a broad scale stripe at each lateral margin. Elytra ovate, each elytron with nine puncture rows, of which the ninth row is at the apical fifth, groovelike depressed, with six large more or less oval scale spots. The first row with three spots between first and fourth puncture rows, the second row with one spot in the middle between fifth and eighth puncture rows, and the third row with two spots, one, placed somewhat anteriorly, between the seventh and ninth puncture rows, the other between the eighth and ninth puncture rows. Mesosternum, metasternum, and first abdominal sternite laterally with a scale spot. Hind femora reaching to apex of elytra.

Female (?), length, 8.5 millimeters; width, 3.6.

LUZON, Benguet Subprovince, Baguio.

This species, which I know only from Heller's description,

presumably refers to a female specimen and seems very closely related to *Exnothapocyrtus cylindricollis* Heller.

Exnothapocyrtus erythromerus Heller.

Nothapocyrtus erythromerus HELLER, Philip. Journ. Sci. § D 7 (1912) 336.

Nothapocyrtus subpilosulus HELLER, Philip. Journ. Sci. 19 (1921) 546.

Castaneous brown to black; head, prothorax, elytra, and legs beset with fine, scattered, whitish hair. Closely related to *E. cylindricollis* Heller. Rostrum one and one-half times as long as broad, rather strongly divergent toward apex, with a well-pronounced shallow dorsal depression in basal half, scatteredly punctured. Front with an almost obsolete medial groove. Prothorax scatteredly punctured, with faint traces of a groovelike medial depression in basal half and a few pale bluish white scattered scales at each lateral margin. Elytra regularly striate-punctate, the punctures more or less obsolete toward lateral margin. At lateral margin before the middle a small pale greenish scale spot and behind the middle an oblong spot. Apical part of elytra and underside black, the latter also beset with scattered and fine whitish hair.

Male, length, 9.5 millimeters (without rostrum); width, 3.8. Female, length, 10 millimeters (without rostrum); width, 4.

LUZON, Benguet Subprovince, Baguio; Mount Santo Tomas (*Schultze*).

The scale markings in this species are variable, in some specimens almost absent. I have no doubt that the description of *Nothapocyrtus subpilosulus* Heller refers to a female of this species.

Exnothapocyrtus luzonicus Schultze.

Nothapocyrtus luzonicus SCHULTZE, Philip. Journ. Sci. § D 12 (1917) 256, pl. 1, fig. 6, ♀.

Castaneous, very glossy. Rostrum dorsally with irregular and scattered punctures, a large shallow depression, and an indistinct longitudinal groove terminating between eyes. Prothorax finely and irregularly punctured, with a large light green or bluish scale spot at lateral margin. Elytra finely but distinctly striate-punctate. Each elytron with four lapis lazuli colored scale spots, two at base, one of which is near suture and the other at lateral margin, an oblong spot apically at lateral margin, and one spot at apical triangle. Besides the above-mentioned spots there are traces of another, in the female only, at lateral margin before the middle. Female with the suture

apically strongly swollen, at apex with a triangular excision, in the male the latter evenly rounded. Mesosternum and metasternum with a scale spot laterally. Legs finely and scatteredly punctured and finely setose.

Male, length, 11 millimeters (without rostrum); width, 4.5. Female, length, 12 millimeters (without rostrum); width, 5.

LUZON, Benguet Subprovince, Pauai (Haight's place) (*Schultze*).

Exnothapocyrtus basifasciatus Heller. Plate 1, fig. 5, ♂; Plate 2, fig. 25, ♂ (lateral view).

Nothapocyrtus basifasciatus HELLER, Philip. Journ. Sci. 19 (1921) 545.

Castaneous brown to almost black, glossy, prothorax and elytra with cobalt blue scale markings. Rostrum very similar to *E. luzonicus* Schultze. Prothorax finely and scatteredly punctured, the punctures somewhat obliterated. Dorsolaterally an indistinct scale spot, absent in some specimens; at lateral margins another large and irregular scale patch. Elytra elongate-elliptic, striate-punctate, the punctures finer toward apex and near the latter more or less pronouncedly punctate-striate. At base an irregular blue crossband, in the middle another irregular transverse band, which may be absent; before and behind the middle of margin a scale spot, and a roundish or triangular spot before apex. Mesosternum and metasternum laterally also with a blue scale patch. Hind femora in the male extending well beyond apex of elytra. Penis structure, Plate 2, fig. 33.

Male, length, 11 to 11.8 millimeters (without rostrum); width, 4.5 to 4.8.

LUZON, Nueva Vizcaya Province, Imugan (*Baker*); Santa Fe Road near Baletè Pass (*Schultze*): Kalinga Subprovince, Davangan (*Herre*).

This species was also described from a single specimen, a male (?). It seems very variable in the scale markings, since in one of the two specimens (males) before me, the dorsolateral spots on prothorax are absent as well as the band in the middle of elytra. Furthermore, the punctures on prothorax and elytra are somewhat variable, more or less strongly pronounced. This species is very closely related to *E. luzonicus* Schultze.

ILLUSTRATIONS

[Original drawings by W. Schultze.]

PLATE 1

FIG. 1. *Macrocyrtus* (*Exmacrocyrtus*) *multipunctatus* Schultze, male, × 2. Luzon, Nueva Vizcaya Province, Imugan.

2. *Macrocyrtus* (*Macrocyrtus*) *subcostatus* Heller, male, × 2. Luzon, Benguet Subprovince, Mount Santo Tomas.
3. *Macrocyrtus* (*Macrocyrtus*) *nigrans* Pascoe, female, × 2. Luzon, Benguet Subprovince, Baguio.
4. *Nothapocyrtus translucidus* Heller, female, × 2.5. Luzon, Benguet Subprovince, Mount Santo Tomas.
5. *Exnothapocyrtus basifasciatus* Heller, male, × 2. Luzon, Kalinga Subprovince, Davangan.
6. *Macrocyrtus* (*Exmacrocyrtus*) *erosus* Pascoe, female, × 2. Luzon, Benguet Subprovince, Baguio.
7. *Macrocyrtus* (*Exmacrocyrtus*) *ilocanus* Schultze, male, × 2. Luzon, Ilocos Norte Province, Mount Palimlim.
8. *Macrocyrtus* (*Exmacrocyrtus*) *trivittatus* Schultze, female, × 2. Luzon, Nueva Vizcaya, Imugan.
9. *Eumacrocyrtus canlaonensis* Schultze, female, × 2. Occidental Negros, Mount Canlaon.
10. *Macrocyrtus* (*Exmacrocyrtus*) *kalinganus* Schultze, male, × 2. Luzon, Kalinga Subprovince, Balbalan.
11. *Macrocyrtus* (*Exmacrocyrtus*) *negrito* Heller, male, × 2. Luzon, Benguet Subprovince, Mount Pulog.

PLATE 2

FIG. 1. *Macrocyrtus* (*Exmacrocyrtus*) *erosus* Pascoe, male.

2. *Macrocyrtus* (*Exmacrocyrtus*) *erosus* Pascoe, female.
3. *Macrocyrtus* (*Macrocyrtus*) *nigrans* Pascoe, male.
4. *Macrocyrtus* (*Macrocyrtus*) *nigrans* Pascoe, female.
5. *Apocyrtus inflatus* Erichson, male.
6. *Apocyrtus inflatus* Erichson, female.
7. *Nothapocyrtus translucidus* Heller, male.
8. *Nothapocyrtus translucidus* Heller, female.
9. *Macrocyrtus* (*Exmacrocyrtus*) *kalinganus* Schultze, female.
10. *Macrocyrtus* (*Exmacrocyrtus*) *trivittatus* Schultze, male.
11. *Macrocyrtus* (*Macrocyrtus*) *castaneus* Pascoe, male.
12. *Macrocyrtus* (*Macrocyrtus*) *castaneus* Pascoe, female.
13. *Pseudapocyrtus formicarius* Heller, male.
14. *Pseudapocyrtus formicarius* Heller, female.
15. *Exnothapocyrtus cylindricollis* Heller, male.
16. *Exnothapocyrtus cylindricollis* Heller, female.
17. *Pseudapocyrtus imitator* Heller, male.

18. *Pseudapocyrtus imitator* Heller, female.
19. *Eumacrocyrtus canlaonensis* Schultze, male.
20. *Eumacrocyrtus canlaonensis* Schultze, female.
21. *Macrocyrtus* (*Exmacrocyrtus*) *multipunctatus* Schultze, male.
22. *Pseudapocyrtus schadenbergi* Heller, female.
23. *Pseudapocyrtus catanduanensis* Schultze, male.
24. *Pseudapocyrtus catanduanensis* Schultze, female.
25. *Exnothapocyrtus basifasciatus* Heller, male.
26. *Pseudapocyrtus apicatus* Schultze, female.
27. *Apocyrtus inflatus* Erichson.
28. *Pseudapocyrtus formicarius* Heller.
29. *Pseudapocyrtus catanduanensis* Schultze.
30. *Apocyrtus mcgregori* sp. nov., male.
31. *Apocyrtus mcgregori* sp. nov., female.
32. *Exnothapocyrtus cylindricollis* Heller.
33. *Exnothapocyrtus basifasciatus* Heller.
34. *Nothapocyrtus translucidus* Heller.
35. *Macrocyrtus* (*Macrocyrtus*) *nigrans* Pascoe.
36. *Macrocyrtus* (*Macrocyrtus*) *subcostatus* Heller.
37. *Macrocyrtus* (*Exmacrocyrtus*) *ilocanus* Schultze.
38. *Macrocyrtus* (*Exmacrocyrtus*) *erosus* Pascoe.
39. *Macrocyrtus* (*Exmacrocyrtus*) *multipunctatus* Schultze.
40. *Macrocyrtus* (*Exmacrocyrtus*) *trivittatus* Schultze.
41. *Eumacrocyrtus canlaonensis* sp. nov.

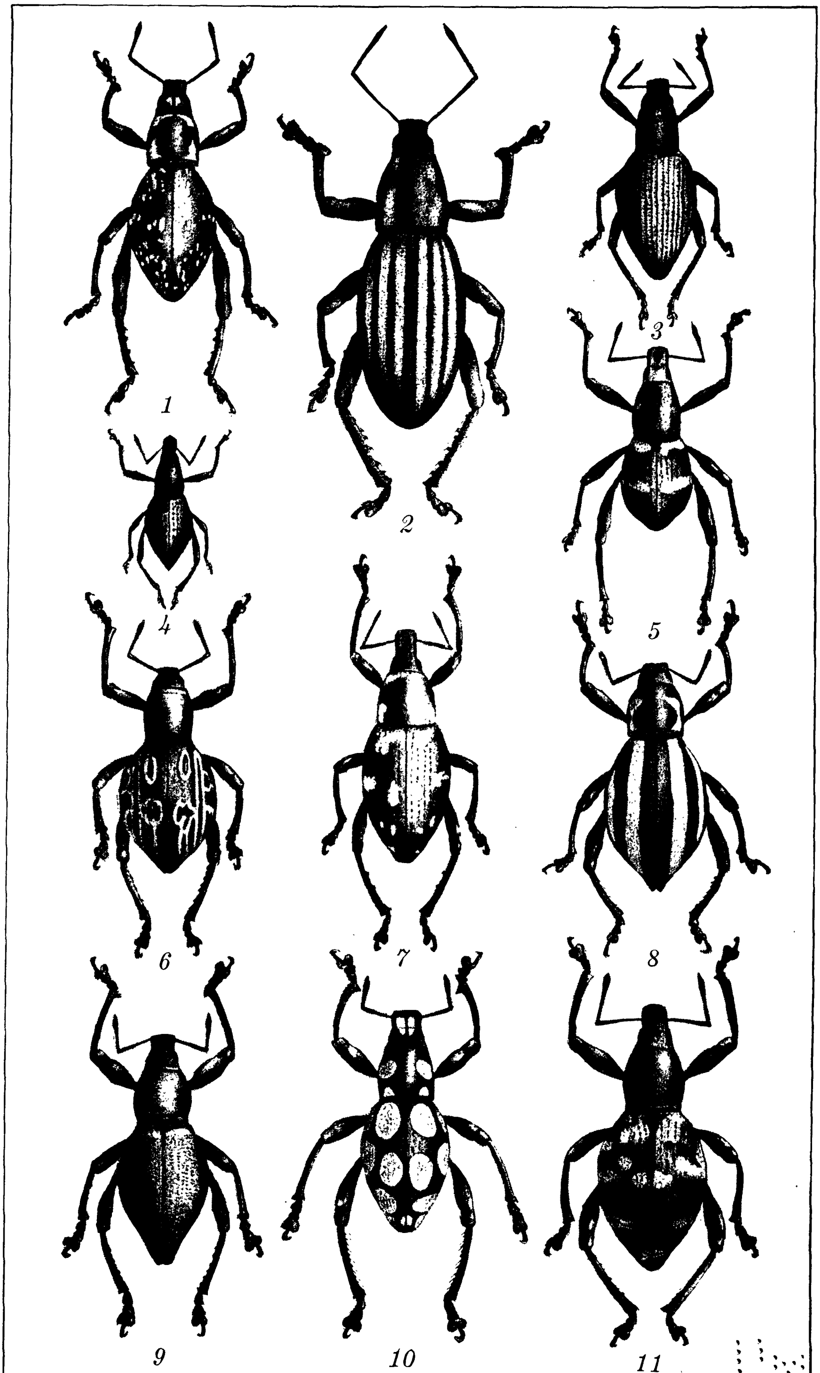


PLATE 1.

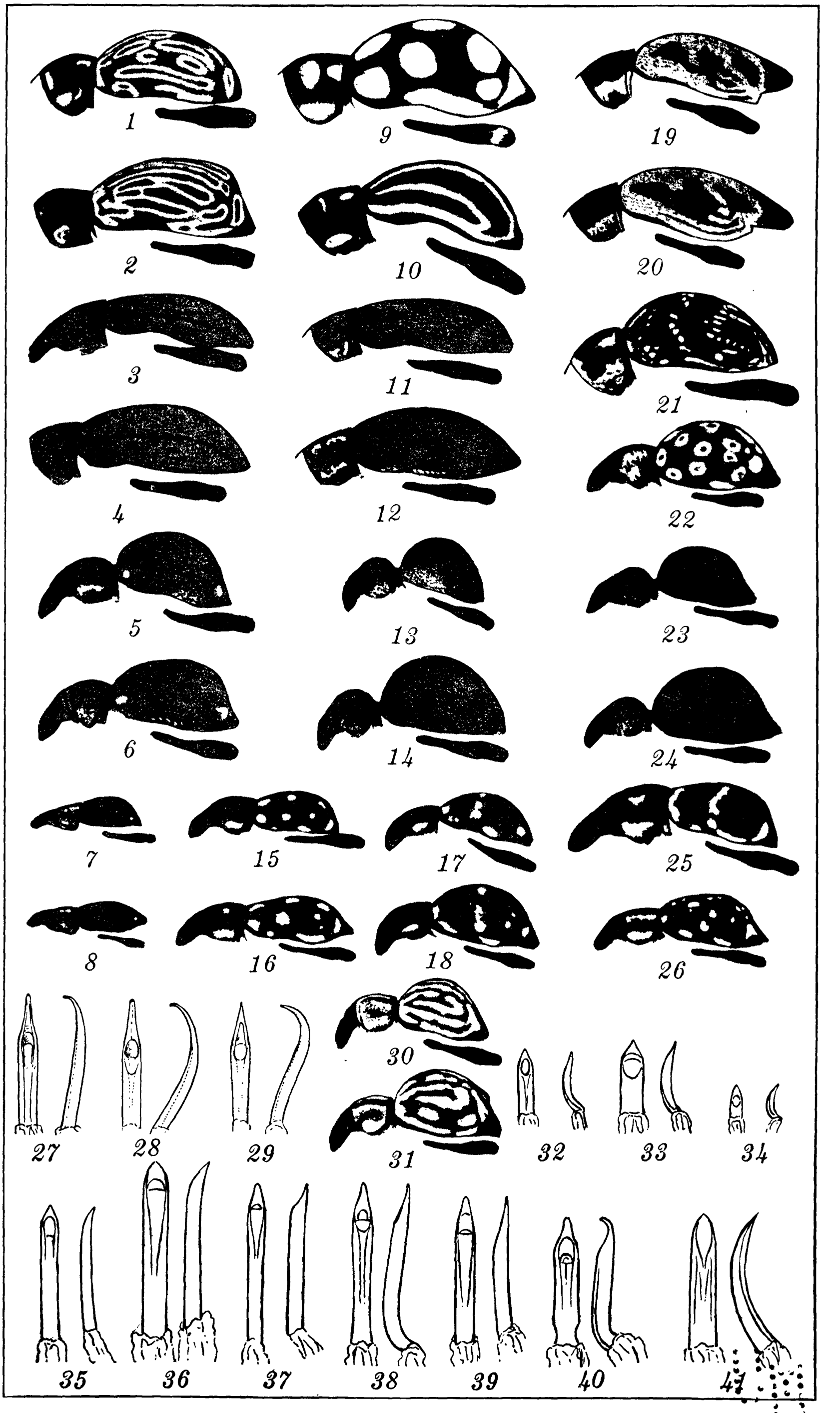

1
9
19
2
10
20
3
11
21
4
12
22
5
13
23
6
14
24
7
15
17
25
8
16
18
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41

PLATE 2.

VOL. 25, NO. 4 OCTOBER, 1924

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1924

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science of the Government of the Philippine Islands

---

Manuscript intended for publication should be sent to the editor. One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Library, Bureau of Science, Manila, P. I.

The Journal is issued twelve times a year. The subscription price is 5 dollars, United States currency, per year. Single numbers, 50 cents each.

Subscriptions may be sent to the BUSINESS MANAGER, Philippine Journal of Science, Bureau of Science, Manila, P. I., or to any of the agents listed on the third page of this cover.

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 25 OCTOBER, 1924 NO. 4

SOME DIPTERA PUPIPARA FROM THE PHILIPPINE ISLANDS

By G. F. FERRIS

Of Stanford University, California

SEVEN TEXT FIGURES

Through the kindness of Prof. C. F. Baker a second small collection of Philippine Diptera Pupipara has become available and is here reported upon. It includes five species, of which four are from bats and were collected by Mr. Edward H. Taylor. Although these four bat-infesting species are described forms, I am here redescribing or figuring them, as the existing descriptions and figures are perhaps not readily accessible to eastern workers, and in some cases are not as satisfactory as might be desired.

A word as to the identification of species in this group may not be amiss. Almost all of the species are more or less soft-bodied, especially the female. Also, the abdomen of the female is subject to very striking, even though superficial, changes in appearance depending upon whether or not the insect is gravid. It consequently follows that care is necessary in interpreting the abdominal structures, for an insect that has but recently issued and is not full-fed may look at first glance very different from one of the same species that is full-fed or that has the abdomen distended by a fully formed larva. It is a most difficult, and in fact nearly impossible, feat to figure with any satisfactory degree of accuracy an individual in which the abdomen is shrunken and more or less telescoped. It may also be expected that forms in which the vestiture of setæ is

so extraordinarily developed will show a rather high degree of variability, and apparently some do. Just how much variation may be allowed before considering that specific limits have been overstepped remains to be determined, for in the case of most of the species long series have rarely been available. These facts should be clearly recognized by anyone who attempts to work in this group.

HIPPOBOSCIDÆ

Genus **ORNITHOPHILA** Rondani

But a single species of this genus has been known, although it was described as long ago as 1879, and this species was described from a single specimen. The description of the genus is clear enough, but that of the genotype, *O. vagans* Rondani, is so inadequate that its identity will probably long remain in doubt, unless the type is still in existence or specimens can be obtained from near the type locality.

It is consequently of considerable interest to find a species apparently referable to this genus occurring in the Philippines. There seems to be no question that this species is really referable to *Ornithophila* and, in view of the inadequacy of the description of *O. vagans* and the very great improbability that the Philippine species can be identical with the latter, which was described from Italy, I am describing it as new.

Ornithophila maquilingensis sp. nov. Figs. 1 and 2.

Material examined.—A single female, taken in flight in the forest on Mount Maquiling. This specimen is returned to Professor Baker.

Female.—General color a rather light brown. Length, 4 millimeters. Head (fig. 1) slightly broader than long; dorsal side destitute of setæ except three along the orbit, one being at the cephalic margin, one at the center, and one at the posterior margin, these long and slender, and a few very minute setæ between the cephalic and median long setæ; ventral side with numerous small, pale setæ; antennæ small and short; anterior margin of head produced past the apices of antennæ and with a deep median emargination; palpi and rostrum of nearly equal length, three-fifths as long as the head itself, the palpi with numerous small setæ; ocelli small but distinct.

Thorax with the humeral angles strongly produced into a broad, laterally rounded prominence bearing numerous small

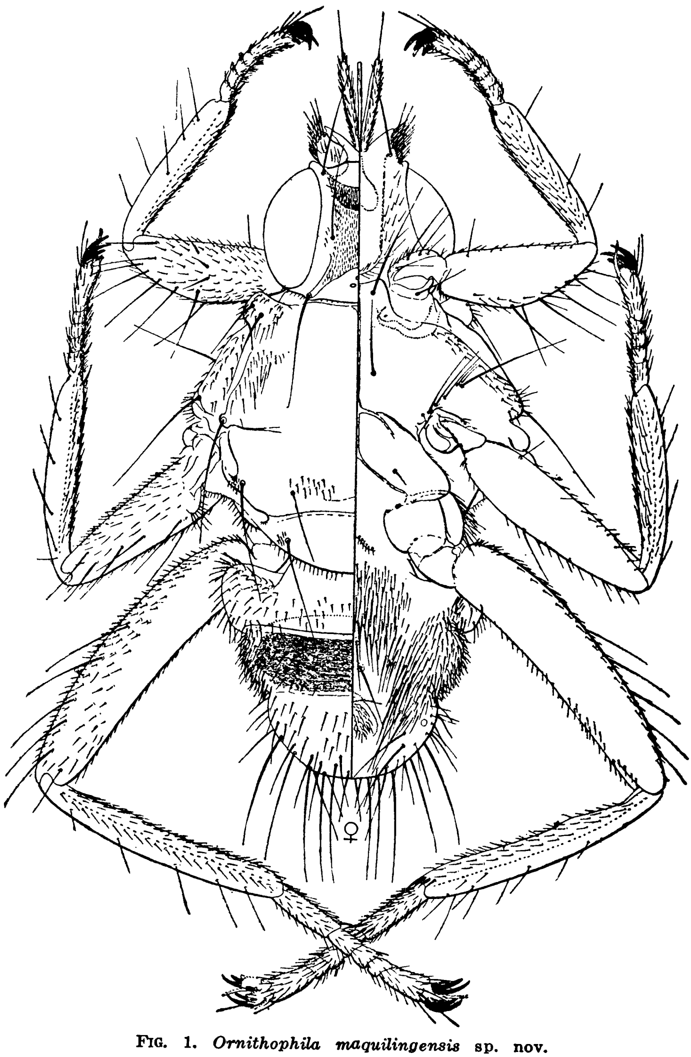


FIG. 1. *Ornithophila maquilingensis* sp. nov.

setæ and one long seta; lateral margins of mesothorax with numerous small setæ and a single long seta just in front of the wing; mesonotum with a single prealar, one postalar, and one prescutellar and one scutellar seta on each side, these long and slender, and with numbers of very small setæ cephalad of the prealar and mesad of the prescutellar setæ; scutellum broadly rounded and fringed with a few minute setæ. Ventral side with the mesosternum slightly produced between the anterior coxæ; destitute of setæ except a pair of long ones between the

anterior coxæ and a similar pair slightly farther back, a row of long setæ cephalo-laterad of the middle coxæ and numerous very small setæ along the lateral margin of the mesosternum.

Legs large and long, the claws three-toothed (fig. 2, *b*); all the segments on the hind tarsi margined laterally by a continuous series of small serrations (fig. 2, *c*), these much fewer and less conspicuous on the other legs.

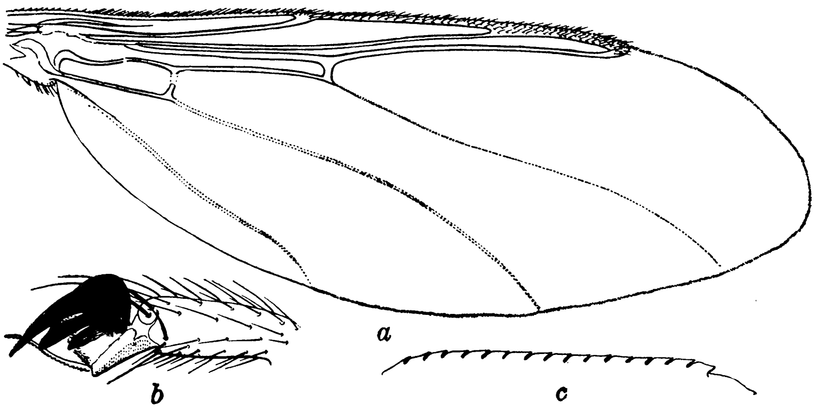


FIG. 2. *Ornithophila maquilingensis* sp. nov.

Wings (fig. 2, *a*), 5 millimeters long, with but two cross veins and consequently without an anal cell; completely and uniformly covered with minute setulæ except for a very narrow marginal area behind the anal vein, these setulæ imparting a gray color to the wing. It is impractical to show these in the figure.

Abdomen with a large basal tergite bearing a few small setæ; behind this is an area in which the derm is practically destitute of setæ and shows a very fine and close, transverse striation; posterior third of the dorsum composed of a single large plate bearing a number of large marginal setæ and a few small dorsal setæ. Ventral side membranous, with numerous setæ over the anterior half and several long setæ laterad of the genital opening.

Notes.—The single specimen available has the abdomen much shrunken and consequently it is impossible to determine the exact arrangement of the setæ on the ventral side. An expanded individual would probably look somewhat different but should be identifiable from the description and figures given.

STREBLIDÆ

Genus NYCTERIBOSCA Speiser

Nycteribosca amboinensis (Rondani). Figs. 3 and 4.

Nycteribosca amboinensis (Rondani) SPEISER, Archiv für Naturgeschichte 66: 1 (1900) 48.

Previous records.—Amboina and Burma, from unknown hosts.

Specimens examined.—A male and several females from a bat, *Miniopterus eschscholtzii,* Tablas Island (*E. H. Taylor*).

Female.—A moderately dark brown and extraordinarily hairy species. Length, 3 millimeters. Head concolorous with the rest of the body, the eyes scarcely recognizable, the entire head, both dorsally and ventrally, beset with numerous setæ; palpi broad and flat, fringed with long and short setæ and with numerous short setæ on the ventral side.

Thorax almost spherical, somewhat flattened dorsally and ventrally, almost concealed from the dorsal aspect by the great numbers of long, slender setæ which beset the entire dorsum and extend to the margin of the ventral side. Ventral side thickly and uniformly beset with small setæ.

Wings (fig. 4) slightly shorter than the body, beset with many slender setæ along the costal border and with areas of setulæ as indicated in the figure; veins weak, arranged as indicated in the figure.

Legs with the femora thickly beset above with long setæ except for a basal bare area; remainder of the legs thickly beset with small setæ.

Abdomen with the basal tergite divided into two broad lobes which have the apical third beset with many long setæ. Remainder of the dorsum thickly beset with slender setæ except for a broad, median area which is entirely bare. The setæ along each side of this area are especially long. Ventral side with an inconspicuous basal plate, this and the greater part of the remainder beset with small setæ. Apex of the abdomen terminating in a median lobe which bears numerous rather long setæ.

Male.—In its general characters like the female, but with the apex of the abdomen acutely pointed. Genitalia entirely internal, very small, apparently without the two flaps seen in the male of *Nycteribosca gigantea.* It is not possible to figure them from the specimen available.

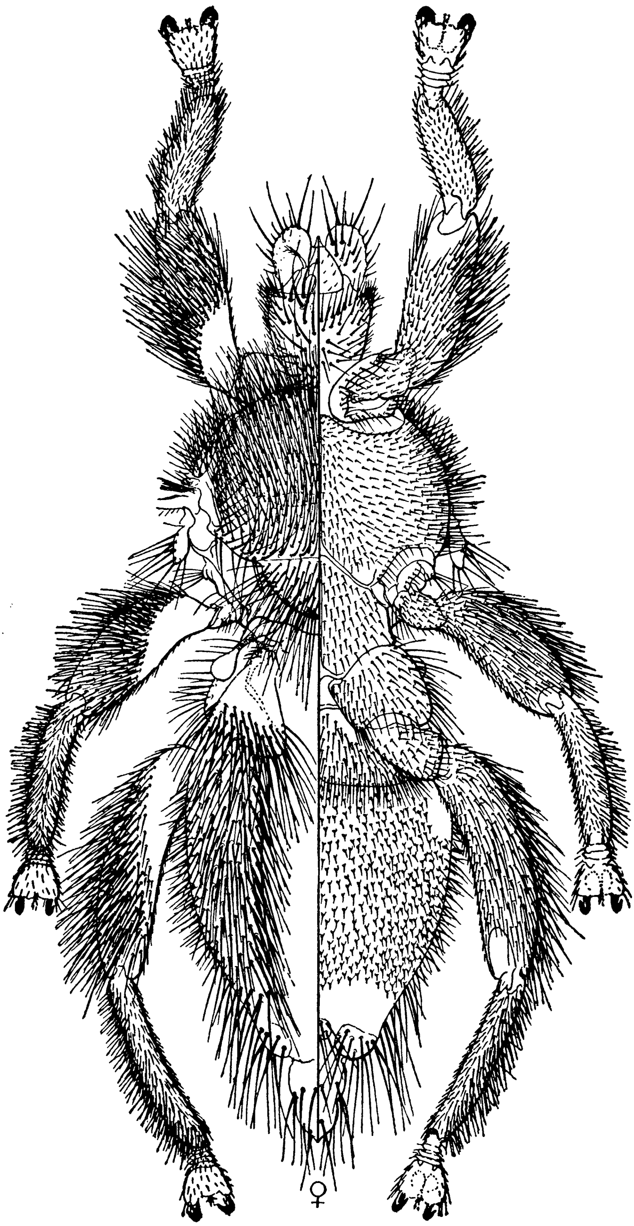


FIG. 3. *Nycteribosca amboinensis* (Rondani).

Notes.—The determination of this species is based entirely upon the key given by Speiser (reference cited) but seems to be reasonably certain. The species differs very markedly from *Nycteribosca gigantea,* which I have redescribed in an earlier

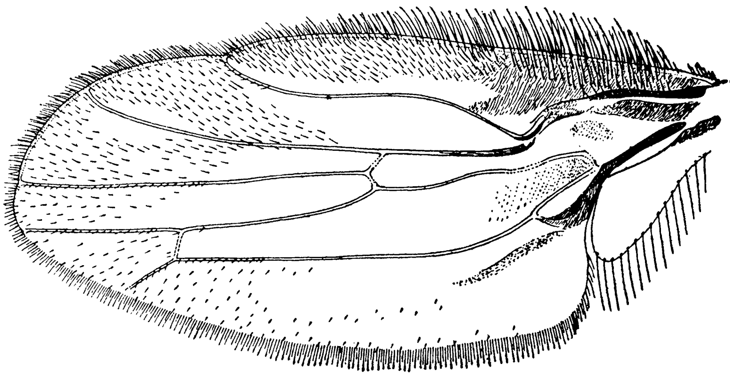


FIG. 4. *Nycteribosca amboinensis* (Rondani).

paper. Apparently it can be confused only with *N. kollari* (Frauenfeld) and the somewhat doubtfully distinct *N. diversa* (Frauenfeld) which occur in the Mediterranean region. According to Speiser it differs from these in its darker color and in the fact that the "fifth vein" (M_3+Cu_1) attains the margin of the wing.

NYCTERIBIIDÆ

Genus NYCTERIBIA Latreille

Nycteribia allotopa Speiser. Fig. 5.

Nycteribia (*Listropodia*) *allotopa* SPEISER, Archiv für Naturgeschichte 67: 1 (1901) 47, tf. 1*b*.

Nycteribia (*Listropodia*) *insolita* SCOTT, Trans. Ent. Soc. London (1908) 364, pl. 18, figs. 9–13.

Nycteribia (*Listropodia*) *allotopa* SPEISER, Scott, Archiv für Naturgeschichte 79 (A) (1913) 97; Ann. Mag. Nat. Hist. VIII 14 (1914) 221.

Previous records.—From *Miniopterus schreibersi*, Ceylon, China, and Formosa. From undetermined host, Sumatra.

Specimens examined.—From *Miniopterus eschscholtzii*, Tablas Island, and from either the same host or *Chaerophon luzonus*, Pagsanjan Falls, Laguna Province, Luzon, all collected by E. H. Taylor.

Notes.—This species appears to be extremely abundant on bats of the genus *Miniopterus* throughout the entire Orient. The various references cited contain adequate descriptions, but I am offering figures for convenience. The species seems to occur ordinarily in company with the next, *Nycteribia parvula* Speiser, and it is somewhat difficult to associate the sexes with each other.

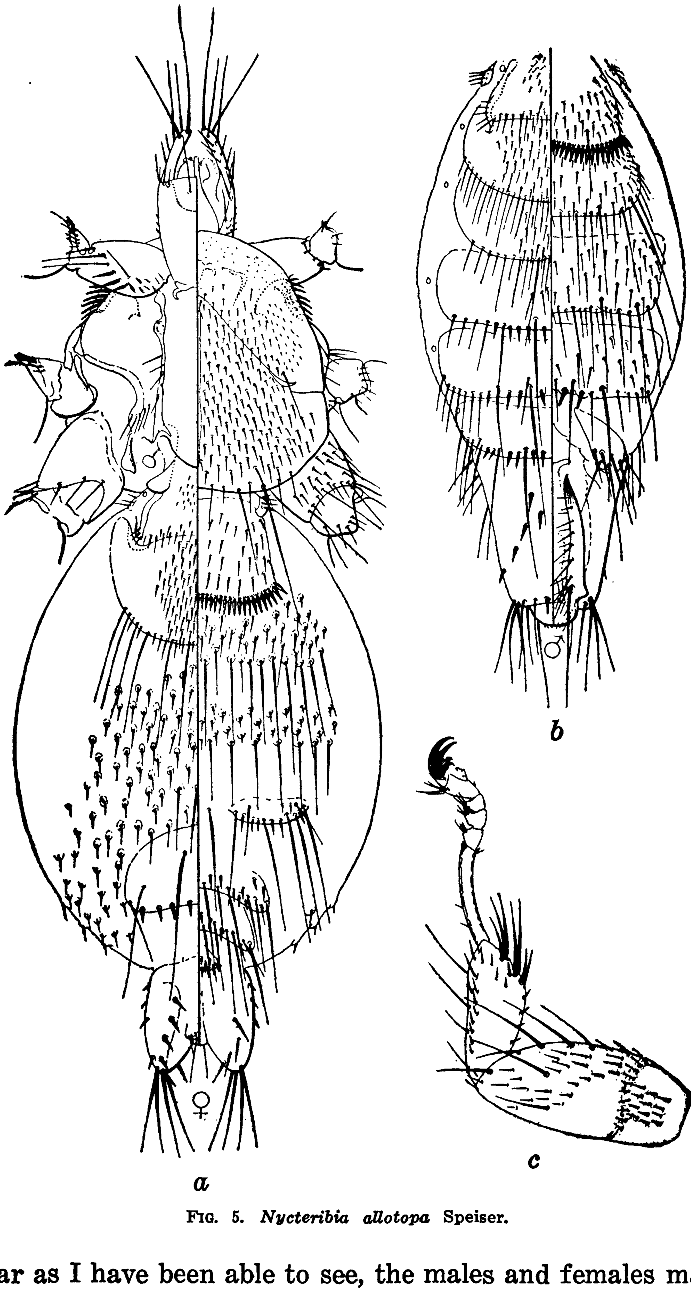


FIG. 5. *Nycteribia allotopa* Speiser.

As far as I have been able to see, the males and females may be correlated chiefly by the form and extent of the abdominal ctenidium. In *N. allotopa* this ctenidium contains from 34 to 40 setæ and those on the meson are distinctly shorter than the others,

while in *N. parvula* it contains from 40 to 44 teeth, which are more nearly of equal length throughout.

Nycteribia parvula Speiser. Fig. 6.

Nycteribia (*Listropodia*) *parvula* SPEISER, Archiv für Naturgeschichte 67: 1 (1901) 48.

Nycteribia (*Listropodia*) *sauteri* SCOTT, Trans. Ent. Soc. London (1908) 366, pl. 18, figs. 14–18.

Nycteribia (*Listropodia*) *parvula* SPEISER, Scott, Archiv für Naturgeschichte 79 (A) (1914) 98; Ann. Mag. Nat. Hist. VIII 14 (1914) 222.

Previous records.—From *Miniopterus schreibersi*, Ceylon and Formosa. From undetermined host, Sumatra.

Specimens examined.—From *Miniopterus eschscholtzii*, Tablas Island, and from the same host or *Chaerophon luzonus*, Pagsanjan Falls, Laguna Province, Luzon, all collected by E. H. Taylor.

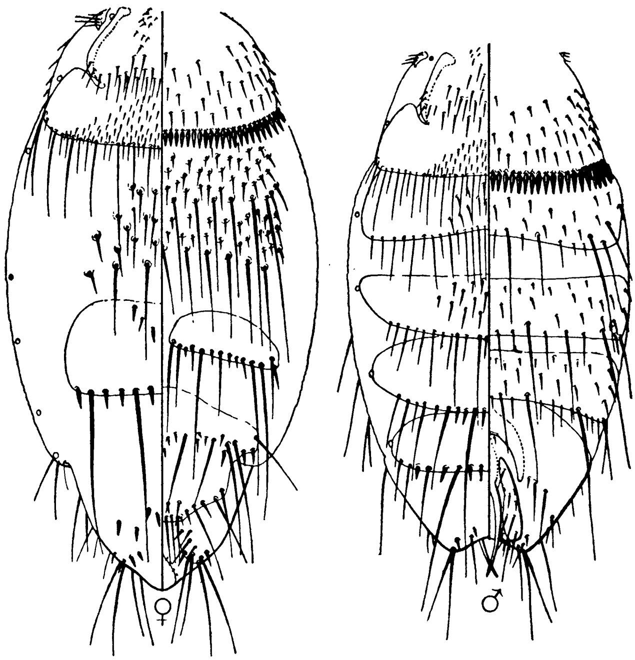


FIG. 6. *Nycteribia parvula* Speiser.

Notes.—This species, like the preceding, has been very adequately described, but I am presenting new figures. In the characters of the head and thorax it is practically identical with *Nycteribia allotopa*, so nearly so that I have not figured this portion of the body, but the abdomen is very different in both sexes and the legs are slenderer. The short terminal seg-

ment of the male and the very small, weak, and pale claspers are especially distinctive.

Genus **PENICILLIDIA** Kolenati

Penicillidia jenynsi (Westwood). Fig. 7.

Penicillidia ienynsi (Westwood) SPEISER, Archiv für Naturgeschichte **67**: 1 (1901) 38.

Penicillidia jenynsi (Westwood) SCOTT, Trans. Ent. Soc. London (1908) 360, pl. 18, figs. 1–8; Archiv für Naturgeschichte **79** (A) (1914) 95; Ann. Mag. Nat. Hist. VIII **14** (1914) 213.

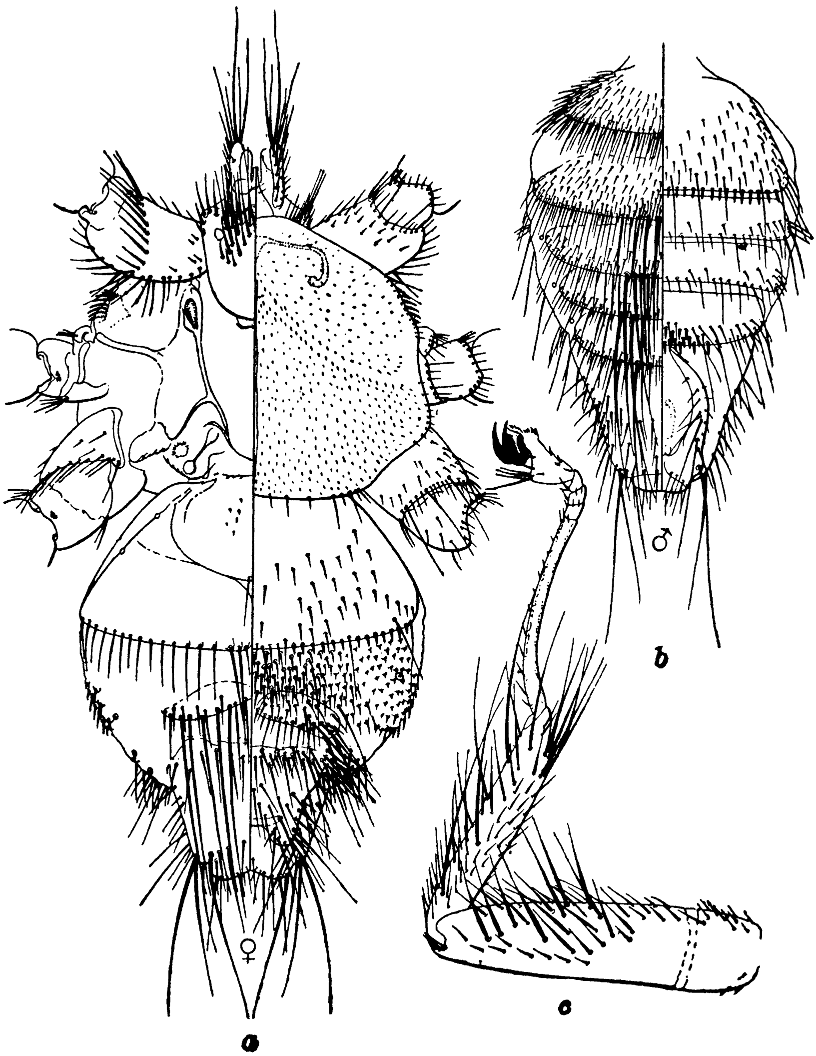


FIG. 7. *Penicillidia jenynsi* (Westwood).

Previous records.—From *Miniopterus schreibersi,* Ceylon. From China, Formosa, and Sumatra without indication of host.

Specimens examined.—From *Miniopterus eschscholtzii,* Tablas Island, and from the same host or *Chaerophon luzonus,* Pagsanjan Falls, Laguna Province, Luzon, all collected by E. H. Taylor There are at hand also a single female from *Miniopterus tristis,* Lubang, Mindoro Province, and one from *Rhinolophus arcuatus,* Irisan, a barrio in Benguet Subprovince, both from alcoholic bats in the United States National Museum.

Notes.—The descriptions in the various references cited are sufficiently complete, but as in the case of the other species herein recorded I am presenting new figures. The species presents some variation, and in the specimen from *Miniopterus tristis* there is a conspicuous cluster of long setæ at the apex of the first abdominal tergite, but the essential specific characters remain constant.

ILLUSTRATIONS

TEXT FIGURES

THE RECOVERY OF FUSEL OIL IN THE PHILIPPINES

By H. E. FOOTE

Chemist, Bureau of Science, Manila

THREE TEXT FIGURES

In investigating the possibilities of the profitable recovery of fusel oil in the distillation of alcohol, the Bureau of Science found that, up to June, 1923, no fusel oil had been recovered in the Philippines. Because the price of fusel oil in the United States was high and there were evidences of a rather serious shortage, it seemed a favorable time for the development of this branch of the alcohol industry in the Islands.

The following facts and results were obtained:

1. The average production of alcohol for the last five years in the Philippines has been 12,257,090 proof liters, or 3,242,616 proof gallons. Table 1 shows the yearly production for this period.

TABLE 1.—*Production of alcohol in the Philippines, 1919 to 1923.*[a]

	1919	1920	1921	1922	1923
Proof liters[b]	14,972,293	11,716,896	9,232,900	11,534,129	13,892,231
Proof gallons[b]	3,960,924	3,099,064	2,442,566	3,051,356	3,658,592

[a] Annual Reports of the Collector of Internal Revenue, Manila.
[b] One U. S. gallon is equivalent to 3.78 liters.

Table 2 shows the percentages of alcohol produced from various sources in 1923.

TABLE 2.—*Sources of alcohol produced in the Philippines in 1923.*[a]

Source.	Proof liters.	Per cent of total.
Nipa sap	3,809,108	27.30
Coco sap	654,903	4.70
Molasses	7,935,548	56.90
Cane sugar	1,539,054	11.00
Grain	83	
Other sources	3,075	.02
Total	13,941,771	99.92

[a] Annual Report of the Collector of Internal Revenue, Manila, 1923.

2. The quantity of fusel oil occurring in the crude alcohol before rectification is about 0.4 per cent. Practically all of the fusel oil formed in fermentation is found in the crude alcohol; that is, little or none is lost in the distillation of the fermented molasses.

3. About 0.2 to 0.23 per cent of fusel oil is actually obtainable on a commercial scale from the crude alcohol.

4. About 65 per cent of the total alcohol output in the Philippines is produced in distilleries large enough to warrant the recovery of fusel oil. The remaining 35 per cent is produced in plants whose capacities are so small that fusel-oil recovery would hardly be profitable. Hence, it is estimated that the potential production of fusel oil in the Philippines, that is, the amount that could probably be recovered profitably, is about 3,500 gallons annually.

5. Assuming a price in the United States of 4 dollars per gallon for the crude grade and 4.75 dollars for the refined grade, and transportation charges of 1 dollar per gallon, the approximate value of fusel oil in Manila on the basis of present prices would be as shown in Table 3.

TABLE 3.—*Approximate value of fusel oil in Manila.*

	Dollars per gallon.	Pesos per liter.	Pesos per pound.
United States price:			
Crude	4.00	2.12	1.16
Refined	4.75	2.51	1.42
Transportation	1.00	0.53	0.29
Manila price:			
Crude	3.00	1.59	0.87
Refined	3.75	1.98	1.13

Hence, the value of the fusel oil available in the Islands would be approximately 10,000 to 13,000 dollars, or 20,000 to 26,000 pesos, annually. Japan is also a market for fusel oil, and it has the advantage that transportation costs from the Philippines to Japan are lower than those from the Philippines to the United States.

Table 4 shows price fluctuations of fusel oil since 1871.

6. The methods of recovery of fusel oil are not difficult, involving only processes familiar to the distiller, and require little additional equipment.

TABLE 4.—*Price per gallon of fusel oil.*[a]

Year.	Refined.	Crude.
	Dollars.	*Dollars.*
1871	4.00	
1881	2.00	
1891	0.50	
1898	0.55 to 0.60	
1901	0.60 to 0.75	
1911	3.00 to 3.25	
1913	1.35 to 1.50	
1918	5.75 to 6.00	
1920	3.85 to 5.00	
1921	2.50 to 4.20	
1922	1.25 to 3.00	
1923	3.00 to 4.75	2.00 to 4.00
1924 [b]	4.75 to (c)	4.00 to 4.30

[a] Oil, Paint, and Drug Reporter No. 14 101 (1922) 45 and 55, idem No. 14 103 (1923) 18 and 73; Drug and Chemical Markets 14 (1924) 283.
[b] January only.
[c] Nominal.

7. Although the quantities of fusel oil produced are small in relation to the quantities of alcohol, the costs of recovery are very low in comparison with its value.

8. One of the largest distilleries in the Islands, at Manila, is now successfully recovering all its fusel oil. Four others are making plans for its recovery as soon as possible. With the exception of one or two on the border line, these five distilleries constitute all of those in which the recovery of fusel oil would be clearly profitable.

Conclusion.—The work of the Bureau of Science has shown that fusel oil can be recovered profitably, and that small but paying quantities can be obtained at low cost and with little difficulty.

The fusel oil obtained from molasses consists mainly of two primary amyl alcohols, namely, the active $\begin{matrix}CH_3\\C_2H_5\end{matrix}\!\!>\!CH.CH_2OH$ (boiling point 131.5) and the inactive or isoamyl alcohol $\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!CH.CH_2.CH_2OH$ (boiling point 129), while the fusel oil obtained from nipa contains, in addition, considerable amounts of intermediate products, chiefly propyl and butyl alcohols. The molasses oil distills almost completely between 127° and 132° C., while the nipa oil distills between 115° and 135° C.

The chief uses of fusel oil are (*a*) as a solvent for nitrocellulose, (*b*) in the manufacture of special paints, varnishes, and lacquers, (*c*) in pharmaceutical work, and (*d*) in the manufacture of artificial perfumes and flavors.

Experiments were carried out to determine the quantities of fusel oil occurring in the manufacture of alcohol, the points in the process where it occurs in greatest quantity, and the best methods of concentration and purification. In most distilleries in the Philippines, the fermented material containing 5 to 8 per cent of alcohol is distilled in a continuous still which produces crude alcohol of 100 to 140 proof, or 50 to 70 per cent strength. This is then rectified in a discontinuous or batch rectifier, the contents of a large boiler being distilled through the usual column, dephlegmator, and condenser giving a distillate which is divided into several fractions as follows: (*a*) "heads" or aldehyde, (*b*) high-grade alcohol, the main product, (*c*) "tails," and, in the case of nipa alcohol, (*d*) "amilico" or fusel oil. The fourth fraction is sometimes obtained in the rectification of molasses alcohol and consists of a fusel oil-alcohol-water mixture containing as a whole 5 to 25 per cent of fusel oil. The percentage of fusel oil occasionally runs much higher (even as high as 80 per cent) for short periods of time during the distillation.

Experiment showed that practically all of the fusel oil formed in the fermentation is carried over into the crude alcohol in the first distillation. No fusel oil was found in the spent wash or "lees," and none was found in the heads, or aldehyde fraction (except for occasional traces due to small quantities of fusel oil being left on the plates of the column from the preceding run).

TABLE 5.—*Values of coefficient k.*

Alcohol, per cent by volume in boiling liquid.	*k* for fermentation amyl alcohol, boiling point 132° C.	*k* for ethyl alcohol, boiling point 78° C.	Alcohol, per cent by volume in boiling liquid.	*k* for fermentation amyl alcohol, boiling point 132° C.	*k* for ethyl alcohol, boiling point 78° C.
95	0.23	1.0037	50	1.20	1.50
90	0.30	1.02	45	1.50	1.63
85	0.32	1.05	40	1.92	1.80
80	0.34	1.08	35	2.45	2.02
75	0.44	1.12	30	3.00	2.40
70	0.54	1.17	25	5.55	2.70
65	0.65	1.23	20		3.30
60	0.80	1.30	15		4.10
55	0.98	1.39	10		5.10

This may be explained by reference to Table 5 and to fig. 1.[1] The figures under k for ethyl alcohol represent the ratio of the percentage of alcohol in the vapor to the percentage in the boiling liquid for various mixtures of alcohol and water; those under k for amyl alcohol represent the ratio of the percentage of fusel oil in the vapor to the percentage in the boiling liquid for mixtures of alcohol and water containing small amounts of fusel oil. Notwithstanding the considerably higher boiling point of the fusel oil, it is seen that this ratio at low alcohol concentration is higher for fusel oil than for alcohol itself.

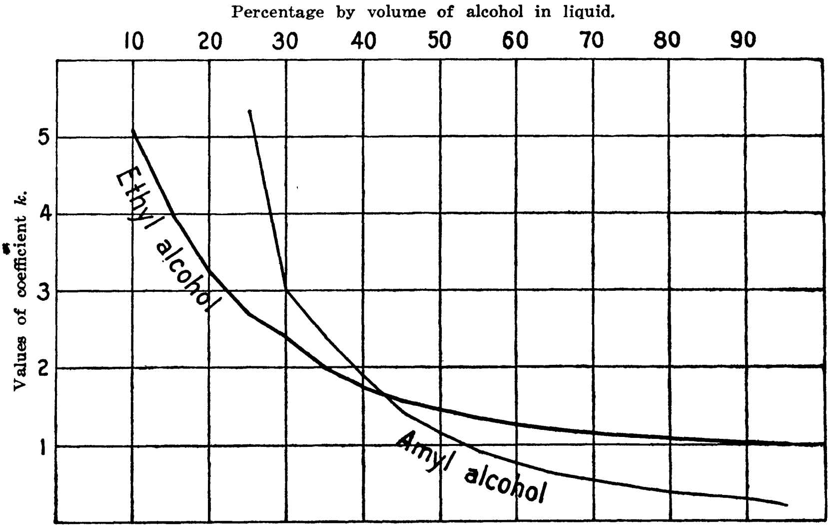


FIG. 1. Values of coefficient k for alcohol and secondary products.

Stated more simply, fusel oil is much more volatile with steam than with alcohol vapor. At concentrations of alcohol below about 43 per cent by volume—the point where the two curves cross—fusel oil is carried over completely; at 43 per cent the fusel oil-alcohol ratio is unchanged before and after distillation; and at higher concentrations of alcohol the fusel-oil content is reduced by fractionation. In the course of the experiments it was observed that at concentrations of alcohol in the distillate of about 90 per cent, or over, no fusel oil (less than 0.1 per cent) came over, whereas below this point as the grade fell off at the end of the rectification, fusel oil appeared in relatively large and increasing quantities (greater than 1 per cent).

[1] Monier-Williams, Power Alcohol. Frowde and Hodder & Stoughton, London (1921) 73, 74.

Therefore, the fusel oil is carried over into the distillate practically without loss in the distillaton of the low-grade fermented material. In the rectification, however, where the alcohol concentration in the column remains high until the "tail" fraction of the run is reached and the alcohol is becoming exhausted, the fusel oil remains behind in the boiler and in the lower part of the column. As the alcohol disappears, the fusel oil, having become concentrated in the water remaining in the boiler, gradually rises in the column until it appears in the distillate, at first in the 90 per cent alcohol, gradually increasing in strength as the alcoholic grade falls. Finally, at a grade of about 40 per cent alcohol or less, the distillate comes over in two immiscible layers, the fusel oil floating on the weak alcohol. The proportion of top layer increases to a maximum, sometimes reaching 100 per cent if large quantities of fusel oil were originally present, and then falls off as the fusel oil is exhausted.

In a few factories in the Philippines, the rectification is carried out in continuous stills. In this case the crude alcohol enters the rectifier at a concentration of 30 to 35 per cent. The fusel oil tends to collect at a point in the column where the alcohol concentration is 43 per cent, as explained above, and is accordingly tapped off from the rectifying column as near this point of maximum concentration as possible.

The above general considerations will make clear the following methods developed for the recovery of fusel oil:

The process of obtaining the fusel oil, when batch rectification is used, consists in selecting that portion of the third and fourth fractions described above (the "tails" and "fusel oil") which is richest in fusel oil and collecting it in a separate tank. This material—in quantity about 1.5 per cent of the total crude alcohol—contains 15 to 20 per cent of fusel oil. The point at which fusel oil begins to appear in worth-while quantities is recognized partly by the hydrometer reading (92° to 93° Gay-Lussac, uncorrected, temperature about 30° C.) and partly by the characteristic residual odor when a sample is rubbed on the hands and allowed to evaporate. The maximum fusel-oil content occurs at a grade of 50° to 60° Gay-Lussac, and the fraction is collected until the grade has fallen to 20° to 30° Gay-Lussac, or until the top layer has practically disappeared.

The fusel-oil content of the distillate at any moment, when the rate of distillation is uniform, plotted against the grade shown by the hydrometer shows a gradual and regular rise and fall as in fig. 2; but, since the grade falls off very slowly at first, then

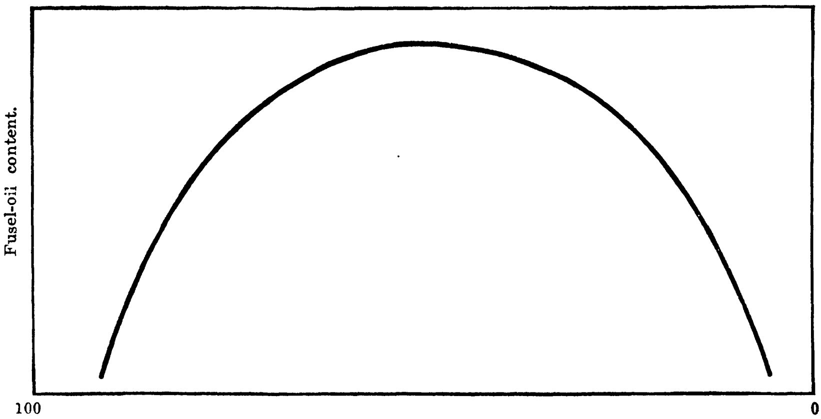


FIG. 2. Fusel-oil content against alcohol content.

with increasing rapidity down to the end, the fusel-oil content plotted against time shows a more gradual increase to a maximum and a rapid decrease at the end, as in fig. 3.

The 20 per cent fusel oil is stored until a sufficient quantity has accumulated and is then rectified in a small batch rectifier giving five fractions: (*a*) heads, (*b*) high-grade alcohol, (*c*) tails, (*d*) 20 per cent fusel oil as before, and (*e*) a fifth fraction in which fusel oil and water come over in two immiscible layers. The greater part of the fusel oil appears in the last fraction. The first fraction is small, the second rather large, the third and fourth are small, and the fifth is rather considerable in amount.

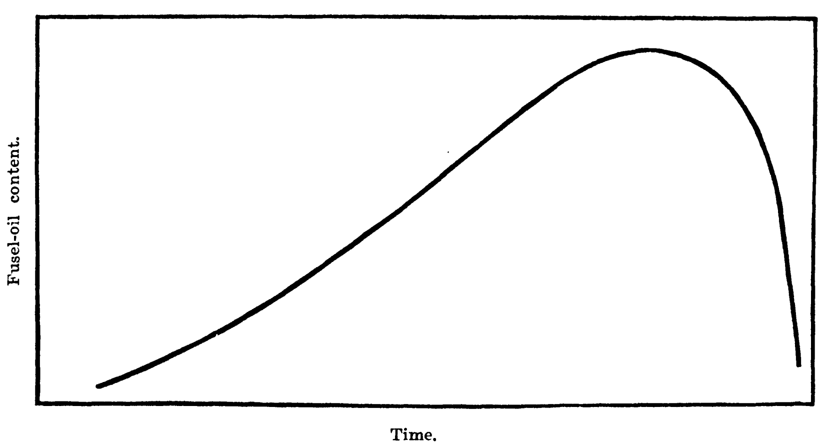


FIG. 3. Fusel-oil content against time.

The first four fractions are disposed of in the usual way exactly as in the large-scale rectification. The fifth is placed in a receiver by itself. The top layer is a fusel oil of from 70 to 90 per cent strength, and the bottom layer (about equal in quantity to the top layer) is water containing small amounts of alcohol and fusel oil.

If a crude fusel oil is desired as the finished product, the oil obtained as above is washed with water till it contains less than 10 per cent of alcohol. If a refined grade is required, the top layer, without washing, is rectified in the same rectifier and collected in three fractions: (1) alcohol containing fusel oil (this is placed in the 20 per cent fusel-oil receiver); (2) two-layer material consisting of (*a*) a top layer of crude 80 to 90 per cent fusel oil, about 70 per cent of the total, and (*b*) a bottom layer of water, about 30 per cent; and (3) refined fusel oil. The third fraction is usually 60 to 75 per cent of the total charge and boils, in the case of molasses alcohol, at 127° to 132° C. The distillation is carried as near to dryness as possible, using a gauge steam pressure of 50 to 150 pounds on the heating coil. In order to prevent excessive refluxing from the dephlegmator into the rectifying column, cooling water is not allowed to circulate after the two-layer fusel oil-water mixture is coming over; and when the dry fusel oil boiling above 127° is coming over, it is advisable to draw off the cooling water from the dephlegmator, leaving it dry.

If the rectification of alcohol in the plant is carried out continuously, the fusel oil will tend to collect on two or three plates where the alcohol concentration is approximately 43 per cent. The liquid on these plates is drawn off at such a rate and at such intervals that the fusel oil is prevented from accumulating on them in large quantities and is obtained at a maximum concentration. The fusel oil so obtained is partially freed from alcohol by washing and is further purified by rectification, as described.

Acknowledgement is made to Carlos Palanca and to Ayala & Co. for their kindness in furnishing facilities in their plants for the carrying out of this work.

ILLUSTRATIONS

TEXT FIGURES

POISONOUS AND WORTHLESS FISHES

AN ACCOUNT OF THE PHILIPPINE PLECTOGNATHS

By Albert W. C. T. Herre

Chief, Division of Fisheries, Bureau of Science, Manila

TWO COLORED PLATES

This order of fishes, the Plectognathi, includes the three suborders Sclerodermi, Gymnodontes, and Ostracodermi. Representatives of all of these suborders are common in the Philippines and, since many members of the order are to be looked upon with suspicion, if indeed their flesh is not actually poisonous, a knowledge of their characters becomes highly important.

Some of the members of this order are highly specialized and among the most singular of fishes, but the more generalized forms show plainly their descent from the order known as the Squamipinnes and especially from the Hepatidæ, of which they are a degenerate offshoot. Jordan states that there can be no doubt of a common and comparatively recent origin for the Balistidæ and the Hepatidæ.

The three divisions of this order are very easily recognized. The Sclerodermi have a spinous dorsal and a compressed, more or less distinctly scaled body, and the teeth are distinct and incisorlike. The Gymnodontes have no spinous dorsal, the teeth are fused into a beak with or without a median division in each jaw, and the skin is naked or covered with thorns, prickles, or hairlike bristles. In the Ostracodermi the spinous dorsal is wanting, the teeth are narrow and slender, and the body is inclosed by a rigid box of bone. This group includes the only members of the order with wholesome and palatable flesh. In at least two of the three suborders the flesh nearly always is not only thin, hard, often bitter, and usually unpalatable, but also contains poisonous alkaloids. These produce the disease known as ciguatera in which the nervous system is attacked and violent gastric disturbances, paralysis, and death may follow.

The order is well developed in the Tropics, but is rather feebly represented in cold waters, certain species being carried northward in warm ocean currents to the shores of Japan, Massachu-

setts, and England. Most of the species are comparatively inactive, poor swimmers, and rely upon their spines, bony plates, tough skin, or poisonous flesh for protection.

The Plectognathi are bony fishes in which the skin is usually covered with rough or spiny scales, or with bony modifications of the skin in the form of thorny spines or plates; sometimes the skin is entirely naked or with soft spines or bristles which simulate hair. The skeleton is imperfectly ossified, the number of vertebræ usually small, about fourteen to twenty, rarely much more numerous. In extremely specialized forms the vertebræ are so reduced that the tail fin seems attached to the head and the body is apparently wanting. The gill openings are small, narrow, restricted to the sides in front of the pectorals; the mouth is small, the bones of the upper jaw usually firmly united; the air bladder has no duct. The spinous dorsal is short, reduced to one prominent spine with one or two accessory ones, or else is lacking altogether; belonging to the caudal portion of the vertebral column is a soft dorsal, and opposite it or a little behind is the anal, the two fins usually much alike in shape and size; the ventral fin is reduced to a few spines or is absent, and the pelvic bones are usually elongate.

The sixty species treated in this paper probably represent nine-tenths of those actually dwelling in Philippine waters.

In this paper the length given for any fish does not include the caudal fin, unless it is so stated.

Suborder SCLERODERMI

This group is composed of plectognaths with a body approximating the shape of ordinary fishes, and with scales of regular shape but rough or bearing spines; the spinous dorsal is composed of one or more spines inserted just behind or above the cranium; the jaws have distinct conical or incisorlike teeth.

Key to the families of Sclerodermi.

a^1. Ventral fins each reduced to a large spine, normally articulating with the pelvic bones; scales rounded, more or less spiny, vertebræ nineteen. **Triacanthidæ.**

a^2. Ventral fins wanting or reduced to a single spine at the end of the long pelvic bone; scales rough, rhombic, or spine bearing.

- b^1. First dorsal of three, rarely two spines, the first spine very large, the second locking it in erection; scales comparatively large, rough, bony, forming a coat of mail .... **Balistidæ.**
- b^2. First dorsal of one spine, with rudiment at its base; scales minute, not bony, the edges spinescent and the surface of the body rough velvety.

c^1. Vertebræ eighteen to twenty-one; no barbel; gill openings beneath or behind the eyes.. **Monacanthidæ.**
c^2. Vertebræ twenty-nine or thirty; a long barbel on chin; gill openings before the eyes.. **Psilocephalidæ.**

TRIACANTHIDÆ

HORNFISHES

Local name: *Sungay-sungayan*, Tagalog.

Body laterally compressed, with a similarly flattened, more or less elongate and attenuate snout, and covered with small or minute rounded scales which are more or less spine bearing. Mouth small, opening but slightly, with conical or incisorlike teeth in jaws, arranged in either one or two rows. First dorsal fin composed of three to six strong spines, the first much the largest; the soft dorsal rather long and low and similar to anal; both ventral fins reduced to a strong spine, nearly or quite as large as first dorsal spine and attached to the prominent pelvic bone; vertebræ $9 + 10 = 19$ in *Triacanthus*. The three large spines which give the family its name are locked in position when erect, thus making a formidable means of defense.

This family includes five genera, one Cuban, one Japanese, and three Indo-Australian, with but few species. They are all small and unimportant fishes, excessively abundant at times but rejected as food in most regions. However, the one peculiar to Japan is highly prized in the region about Nagasaki. In the members of this group the percentage of waste is so high that even if their flesh is not positively harmful it is so scanty and unpalatable that it is rejected. In the provinces I have seen fisherman throw away hundreds at a time, taken from their fish corrals. In Manila where the struggle for food is much more severe they are sometimes seen in the markets, mixed with other small fishes. Poor people sometimes seine them in considerable numbers in the bay along the sea wall beside Dewey Boulevard and prepare them in the following manner: The still flopping fish is grasped in both hands and given a quick hard transverse pull, which tears the fish in two directly behind the dorsal and ventral spines. The anterior half is thrown away and the skin is removed by a single jerk from the posterior half, thus yielding about two bites of meat.

I have found some of the characters, usually relied upon for distinguishing species, to be of little value. The presence or absence of a black or dusky spot on the distal portion of the first dorsal spine is not a valid specific character; neither is the

comparative length of the dorsal and ventral spines, since this varies greatly with age. Specific characters that seem to be trustworthy are the comparative size of the scales, the breadth of the muzzle and of the pelvic bone, the comparative lengths anterior and posterior to the ventral spines, and the shape of the snout.

One genus is found in the Philippines.

Genus TRIACANTHUS Cuvier

Triacanthus CUVIER, Régne Anim., ed. 1 (1817) 152, *biaculeatus*.

Body more or less elongate and compressed, covered with minute rough scales; tail slender and prolonged; teeth in two rows in each jaw, the outer one in upper jaw of eight or ten, that in lower jaw of ten incisors; teeth of inner row rounded, two to four in upper jaw, two in lower jaw. First dorsal with one very strong, rough spine, followed by four very much smaller ones; soft dorsal with from twenty-two to twenty-five rays, anal sixteen to twenty; lateral line sometimes conspicuous, especially posteriorly.

Species of this genus occur from the Persian Gulf to Japan and Australia.

Key to the species of Triacanthus.

a^1. First dorsal deep black with a dark blotch below; a black spot in axil of pectoral .... **T. brevirostris.**
a^2. First dorsal not deep black; no black spot in axil of pectoral.
  b^1. Pelvic bone narrow; second dorsal spine not much longer than third; snout shorter, broader .... **T. blochii.**
  b^2. Pelvic bone broad.
    c^1. Second dorsal spine two or three times as long as third; snout elongate, narrow; caudal peduncle five times in length. **T. strigilifer.**
    c^2. Second dorsal spine short; caudal peduncle 6.3 to 7 times in length. **T. oxycephalus.**

Triacanthus brevirostris Schlegel.

Triacanthus brevirostris SCHLEGEL, Fauna Japonica, Poiss. (1846) 294, pl. 129, fig. 2; BLEEKER, Atlas Ichth. 5 (1865) pl. 231, fig. 3; GÜNTHER, Cat. Fishes 8 (1870) 209; JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 253.

Dorsal V, 23; anal 17. Head contained 3.7 times, depth 2.6 times in length; eyes contained 3.8 times in head and 2.5 times in snout, which is slightly concave, but little produced and 1.5 times in head and $2\frac{1}{6}$ times in depth; interorbital space broad, flat with a central ridge, 1.4 times the length of eye; first dorsal spine very stout, its length twice in head and 4.47 times in

head and body; ventral spines shorter and not quite so stout, 1.4 in head and a little over 5 times in length; anal contained 1.45 times in second dorsal, or 68.6 per cent, and 1.39 times in head; caudal peduncle contained 4.85 times in length; ten teeth in outer row in each jaw, the median pairs of comparatively large incisors, four rounded molarlike teeth in inner row above and two large rounded ones below.

Dark bluish gray above and whitish below a line extending from eye to middle of tail; whitish also around eyes and across occiput; interorbital space and snout dark; first dorsal fin deep black, with a dark blotch extending down on back below it; upper half of first dorsal spine white; a black spot in axil of pectorals and a dark blotch below them; a brilliant silvery luster over entire body; the remaining fins all pale.

Here described from a specimen collected at Amoy, China, by S. F. Light. It has a length of 170 millimeters, or 215 millimeters with the caudal fin.

There are several very small, immature specimens in the Bureau of Science collection, which were taken from Manila Bay.

Triacanthus blochii Bleeker.

Triacanthus blochii BLEEKER, Bijdr. Ichth. Singapore, Nat. Tijdschr. Ned. Ind. **3** (1852) 81; Atlas Ichth. **5** (1865) pl. 217, fig. 1; JORDAN and RICHARDSON, Bull. Bur. Fisheries **27** (1907) 272.

Dorsal V, 21; anal 17. Head contained 3.4 times, depth at posterior extremity of first dorsal (excluding the pelvic bone) 2.79 times, and depth at posterior extremity of the soft dorsal 8.27 in length; from tip of snout to ventral spine 28.8 per cent, and from latter to base of caudal 71.2 per cent of length; eyes moderately large, elongate, 3.18 times in head, 2.36 in snout, and 10.9 in length; snout rather short and full, a trifle less than $\frac{3}{4}$ as long as head, and 4.6 times in length; width of muzzle contained 4.37 times in head; first dorsal spine strong, rough, and very long, 3 times in length and $\frac{1}{7}$ longer than head; the remaining spines small, weak, and of approximately the same length except the last, which is very small; ventral spines resemble first dorsal spine but are shorter, being a trifle less than head and contained 3.6 times in length; anal short, its base about 1.6 in that of the soft dorsal; caudal peduncle relatively long and contained 3.3 times in length; eight incisors in outer row and four rounded teeth in inner row on upper jaw; ten teeth in outer row of lower jaw, the last pair much the small-

est, and two rounded teeth in inner row. Scales a little smaller than in *T. strigilifer,* but more spiny pointed and less rounded. Pelvic bone very narrow and sharp, its greatest width 17.5 times in length of head; its origin between the ventral spines.

Color in alcohol nearly uniform yellowish gray, with a dusky blotch on back around base of first dorsal, and short, indistinct dusky crossbands or blotches below the soft dorsal and top of caudal peduncle; underparts paler; upper part of first dorsal spine dusky or black, its lower part very pale or white; all fins pale or yellowish.

Here described from a specimen, 120 millimeters long, taken at Alaminos, Pangasinan, in Lingayen Gulf. Specimens of this and related species of approximately the same length show marked discrepancies when placed with their ventral spines together. In *strigilifer* the long concave snout and head extend much beyond those of *blochii,* while in the latter the trunk and tail extend much farther back than in *strigilifer;* the eyes and the pelvic bones also show marked differences.

The dorsal rays vary from twenty-one to twenty-three, the anal from sixteen to seventeen; the length of the first dorsal spine is subject to considerable variation, in young specimens being always much longer than the head, and in one it is 45.6 per cent of the entire length without the caudal fin; the eyes are proportionately larger also in the young, one-ninth or even one-eighth of the length.

I have examined seven specimens from Alaminos, Pangasinan, ranging from 59 to 123 millimeters in length; one from Calapan, Mindoro, 89 millimeters long; and four from Barotac Nuevo, Panay, from 47 to 81 millimeters long. On the last mentioned the dark bands are much more evident. In life the interspaces between the dark bands are evidently yellow spots or bands.

I also place here four small specimens from Manila Bay, varying from 61 to 82 millimeters in length, and two small, shriveled specimens, 64 and 75 millimeters long, respectively, collected by Alejo Arce at Calabanga, Camarines Sur Province. In all of them the snout and body above a line drawn from the eye to the middle of the caudal is nearly uniform brown, with the dark bands but little evident; all below this line is pale, yellowish to nearly white; the whole fish with a bright silvery luster.

This species is common throughout the Philippines and the East Indian Archipelago.

Triacanthus strigilifer Cantor.

Triacanthus strigilifer CANTOR, Cat. Malayan Fishes, Journ. Roy. Asiatic Soc. Bengal **18** (1849) 363, pl. 9; BLEEKER, Atlas Ichth. **5** (1865) 89, pl. 229, fig. 3; GÜNTHER, Cat. Fishes **8** (1870) 211; JORDAN and SEALE, Proc. U. S. Nat. Mus. **28** (1905) 790.

Dorsal V, 22; anal 17. Depth of body at posterior extremity of first dorsal, not including pelvic bone, 3.15 times in length; depth at posterior extremity of soft dorsal 10.9 in length; head contained 2.92 times in length; distance from tip of snout to ventral spine 37.09 per cent, from latter to base of caudal 62.91 per cent of length; eyes large, elongate, 2.3 in snout, 3+ in head, and 9.2 times in length; snout elongate, concave, with pinched, narrow, somewhat concave cheeks, 0.75 as long as head and 4 times in length; width of muzzle contained 8 times in head; first dorsal spine very strong, rough, and contained 3.75 times in length and 1.28 times in head; the remaining spines weak, the second spine twice or more than twice as long as the others; ventral spines similar to first dorsal spine but shorter, being contained 1.5 times in head; anal short, its base contained 1.6 times in that of second dorsal; caudal peduncle relatively short, being 0.2 of length; teeth of medium or small size, the median pairs much the largest, ten in outer row both above and below, the posterior pair in lower jaw very small; two rounded teeth in inner row in each jaw; scales in this species a little larger than in *T. blochii.* Pelvic bone broad and flat, its width one-tenth of length of head and nearly twice as wide as in *T. blochii;* it lies wholly posterior to the ventral spines.

Color in alcohol uniform yellowish brown, or brownish above and paler below, with a silvery luster over all; upper half of first dorsal spine dusky or blackish.

Here described from a specimen from Manila Bay, having a length of 120 millimeters. This species is easily recognized by its elongate, concave head and snout and meager body, and is distinguished from related species by the greater relative length before the ventral spines and the relatively shorter portion posterior to them.

The dorsal rays vary from twenty-two to twenty-three, the anal from sixteen to eighteen; the first dorsal spine varies

from 3.5 to 3.75 times in length; eye contained about 3 times in head. There are usually but eight teeth in the outer row of the upper jaw.

I have studied five specimens from Manila Bay, ranging from 93 to 120 millimeters in length without the caudal fin. This species occurs from the southern coast of China throughout the East Indies and is generally distributed in the Philippines.

Triacanthus oxycephalus Bleeker.

Triacanthus oxycephalus BLEEKER, Verh. Bat. Gen. 24 (1852) 27, pl. 5, fig. 10; Atlas Ichth. 5 (1865) 90, pl. 220, fig. 3; PETERS, Monatsber. Akad. Wiss. Berlin (1868) 276; REGAN, Proc. Zool. Soc. London (1903) 183.

I have seen no specimens of this triacanthid, which was collected by Jagor at Catbalogan, Samar, as recorded by Peters. It can be readily distinguished from the others described in this paper by the greater number of dorsal rays and the much shorter caudal peduncle, as shown in the following description by Regan:

Depth of body 2⅓–2½ times in total length, length of head about 3 times, length of caudal peduncle 6⅓–7 times. Snout slightly concave, its length about 1⅘ times in the length of head, eye-diameter 3–4 times, interorbital width 3–3¼ times. Interorbital space flat. Upper edge of occipital crest convex; distance from posterior margin of orbit to base of first dorsal spine about 1¾ times as long as the eye-diameter. D. V, 24–25; A. 17–19; first dorsal spine longer than the head, the others short; length of base of anal fin 1⅜–1¾ times in that of the base of the soft dorsal fin; pelvis between the ventral spines broad anteriorly, tapering to a point posteriorly. Membrane of spinous dorsal fin immaculate. Total length 140 mm. Hab. East Indian Archipelago.

BALISTIDÆ

TRIGGER FISHES

Local names: *Papakol,* Tagalog; *pugot* or *puggot,* Visayan and Moro.

This family comprises a considerable number of tropical shore fishes, many of them of medium to rather large size, grouped in a half dozen genera and about fifty species. While some of them display very brilliant colors, as a group they are of singular, often bizarre or grotesque appearance, and lack the beauty and elegance of form and movement characteristic of many of the fishes of the coral reefs. They are carnivorous or partly herbivorous; some of the species feed upon mollusks and crustaceans and sometimes cause great damage to pearl-oyster beds,

their powerful teeth and jaws enabling them to crush the shells and thus get at the soft flesh within.

Although occasionally seen in the fish markets throughout the Orient, none of the Balistidæ are much used as human food. In some localities in the Philippines those of moderate size are eaten, but their sale here should be forbidden as their flesh is always more or less poisonous. In such places as Cuba and Mauritius they are not allowed in the markets as they are known to cause ciguatera.

Francis Day says:[1]

> Dr. Meunier, at the Mauritius, considers that the poisonous flesh acts primarily on the nervous tissue of the stomach, occasioning violent spasms of that organ, and shortly afterwards of all the muscles of the body. The frame becomes racked with spasms, the tongue thickened, the eye fixed, the breathing laborious, and the patient expires in a paroxysm of extreme suffering. The first remedy to be given is a strong emetic, and subsequently oils and demulcents to allay irritability.

In his account of the backboned animals of Abyssinia, Rüppell states that *Balistes flavimarginatus* is very common in the Red Sea at Djetta,[2] where it is often brought to market, although only pilgrims, who do not know the quality of the flesh, will buy it. He goes on to say that as a whole the Balistidæ not only have a bad taste but also are unwholesome as food.

The oblong, ovate, or elliptical body is moderately compressed and is usually very deep anteriorly; it is covered with rather large rough scales, or scutes, of various shapes, which never form an immovable shell, or armor; the mouth is comparatively small, low, and terminal; the short jaws have a single row of separate, stout, coarse, incisorlike teeth; the eyes are very far back and high up, the preorbital being very deep and more or less bony; the small, slitlike, subvertical, or diagonal gill openings are above or in front of the pectorals, and are below or immediately behind a perpendicular from the eyes; the first dorsal is of only two or three spines, the first one is very robust and much the highest; when elevated it is locked in position by the second, which acts as a trigger; behind the first dorsal is a deep groove into which the dorsal spines are folded; it is formed by the fusion of most of the precaudal interneurals to form a bony trough attached to the skull; the second dorsal is usually far

[1] Fishes of India (1878) 686.

[2] "Djetta" I take to be the present City of Jedda, the well-known Arabian seaport, where vast numbers of Mohammedan pilgrims disembark every year on their way to Mecca.

from the first, of numerous soft rays, and opposite the very similar anal, both rather long as a rule; the caudal fin may be truncate, rounded, or deeply lunate, the shape often varying much with age in the same species; the ventral fins are absent, their place occupied by a single, stout, thick spine at the end of the very long and usually movable pubic bone; the precaudal vertebræ have well-developed parapophyses to which epipleurals are attached; the post temporal is short and simple, the forks obliterated, the bone grown solidly to the skull and without a foramen; ethmoid region long, without distinct nasal cavities; the palatine is movably articulated with the ectopterygoid or is entirely free from it; the premaxillaries are not protractile but are firmly united to the maxillaries; the lateral line is very faint or altogether absent. Vertebræ, $7 + 10 = 17$ or, according to Regan, 18.

Five genera and seventeen species are recorded from the Philippines; some of them are very abundant about the coral reefs. Several species of living Balistidæ are kept at the Bureau of Science Aquarium, where they are always of interest owing to their strange shape, coloration, and actions.

Key to the Philippine genera of Balistidæ.

a^1. Teeth white.
  b^1. Teeth uneven, oblique, more or less deeply notched.
    c^1. Caudal peduncle flattened laterally.
      d^1. A groove in front of eye .... **Balistes.**
      d^2. No groove before eye .... **Balistapus.**
    c^2. Caudal peduncle flattened dorsoventrally .... **Abalistes.**
  b^2. Teeth even, incisorlike .... **Melichthys.**
a^2. Teeth red or orange red .... **Odonus.**

Genus BALISTES (Artedi) Linnæus

Balistes LINNÆUS, after Artedi, Syst. Nat. ed. 10, 1 (1758) 327.
Parabalistes BLEEKER, Ned. Tijdschr. Dierk. 3 (1866) 10.
Pseudobalistes BLEEKER, Ned. Tijdschr. Dierk. 3 (1866) 11.
Sufflamen JORDAN, Copeia No. 29 (1916) 27.

This genus of highly specialized fishes has been divided by various authors into several subgenera and genera, and it is probable that differences in scalation, together with the form of the body and the fins, may be taken as generic characters.

Sufflamen may be a valid genus, but neither *Parabalistes* nor *Pseudobalistes* as defined by Bleeker is sufficiently well characterized to stand apart. In view of their intergradation and the unsatisfactory separation from *Balistes* of the three just named, the last named only is retained here.

The compressed body is covered with thick rough scales or plates of small or medium size, which do not overlap; there is a naked groove in front of the eye below the nostrils; the lateral line is very obscure and irregular, and is usually only visible when the scales are dry; the pelvic flap is large, more or less movable, and supported by a series of slender, sharp-pointed spines; the caudal peduncle is laterally compressed, its depth greater than its thickness, and the dorsal and ventral margins not flattened; it may or may not have scales with two to several rows of spines or tubercles and differentiated from the other scales of the body; the first dorsal is of three spines, the first of which is stout, rather blunt, with rough anterior surface, the other spines much smaller and the second acting as a trigger to lock the first when erected; the second dorsal and anal are long, similar to each other; the caudal fin is usually rounded, with the outer rays prolonged in the adults; the gill opening has several enlarged bony plates behind it; the cheeks are covered with scales, though in some species these may partially disappear in large old specimens or they may be in several widely spaced horizontal rows of small tubercles; the snout may be naked, partly covered with rudimentary scales, or entirely scaled: the teeth are irregular, notched, incisorlike, usually four on each side in each jaw; Günther was in error when he stated "Upper jaw with a double series of incisor-like teeth, eight in the outer and six in the inner series." Six of the teeth of the upper row have a long, broad grinding surface behind the outer chisel-like cusp, at least in some if not all of the species, but the whole forms a single tooth, as can be seen by extracting one.

The function of the armament of the tail is not certain; as it is little evident in the young, Günther believes that it may perhaps be a sexual character. While these fishes cause great damage to pearl-oyster beds, it is very probable that there would be few pearls without them. There is reason to believe that they are the host for the adult form of the larval nematode which creeps into the pearl oyster and causes it to secrete pearls.

Key to the Philippine species of Balistes.

a^1. Head entirely scaled up to the lips. (Subgenus *Balistes*.)

b^1. Sides of tail without spines or tubercles.................................... **B. vidua.**

b^2. Sides of tail with several more or less complete rows of spines or tubercles. (Subgenus *Sufflamen*.)

c^1. Two or three rows of large white spots on lower half of body. **B. niger.**

c^2. No rows of large white spots present.
d^1. Pale bands around mouth and extending backward; no conspicuous dark bands on head or body.
e^1. Caudal fin with conspicuous white crescent on posterior margin. **B. chrysopterus.**
e^2. Caudal fin uniform in color with body................ **B. capistratus.**
d^2. No pale bands around mouth; conspicuous dark bands on head or body.
f^1. Membrane of first dorsal with large dark spots; a dark band from above mouth backward toward pectorals; a broad blackish band across eyes to base of pectorals.. **B. viridescens.**
f^2. Membrane of first dorsal uniform in color, very dark.
g^1. A dark crescent across hind margin of eye from below dorsal spine to base of pectoral; a similar band across base of pectoral behind gill slit, to below first dorsal. **B. bursa.**
g^2. Entire back dusky above a line from snout to upper base of caudal; a broad dark band from above pectoral downward and forward toward throat........................ **B. humilis.**
a^2. Snout more or less naked.
h^1. Cheeks with horizontal naked stripes or grooves; scales on tail without spines. (Subgenus *Parabalistes.*)
i^1. Cheek scales reduced to five or six widely spaced rows of small tubercles .... **B. fuscus.**
i^2. Cheek scales separated by six or seven narrow stripes; body covered with irregular narrow dark longitudinal stripes........ **B. rivulatus.**
h^2. Cheeks covered more or less completely with large scales; four to six rows of recurved spines on tail. (Subgenus *Pseudobalistes.*) **B. flavimarginatus.**

Balistes vidua Solander.

Balistes vidua SOLANDER, MS. in Richardson, Zool. Voy. Sulphur, Ichthyology, Part 3 (1845) 128, pl. 59, figs. 9 and 10; GÜNTHER, Cat. Fishes 8 (1870) 216; JORDAN and EVERMANN, Fishes of Hawaiian Islands, Bull. U. S. Fish Comm. 23 [1] (1903) 410, pl. 61.
Melichthys vidua BLEEKER, Atlas Ichth. 5 (1865) 109, pl. 217, fig. 2.

Dorsal III, 34; anal 30. Between seventy-five and eighty scales in lateral line and over seventy in a longitudinal series from gill slit to base of caudal rays; about forty scales between origin of first dorsal and anus; body moderately compressed, its greatest depth midway between first and second dorsals and equal to 0.5 length; the rather short deep head covered with scales to lips, and contained 3.58 times in length; the long, thick snout contained 4.5 times in length and is 81 per cent of length of head; mouth small, subterminal, lower jaw projecting; eyes small, circular, and placed well back, being about half a diameter in advance of first dorsal and contained 5.45 times in head; gill slit nearly vertical and below first dorsal spine, which

is rather stubby and a little more than half as long as head; behind gill slit and over pectoral lie six or seven enlarged bony plates, two of them much larger than the rest; no spines or tubercles on caudal peduncle; ventral spine short, stiff, and blunt; soft dorsal and anal rather high; caudal truncated or very slightly concave.

The above description is of a specimen obtained by me at Olongapo, Zambales, having a length of 218 millimeters, or 250 millimeters including the caudal fin. When fresh the whole fish was uniform brownish black except the posterior portion of the caudal peduncle, which was white; the caudal was pink with a white terminal stripe and a very thin black line along the dorsal and ventral edges; the first dorsal was olive brown; the second dorsal and anal were white, with a narrow black line along the whole margin; the pectorals were bright lemon yellow, the iris of the eyes also yellow; a faint pale line on the lips.

I have also examined a specimen, 204 millimeters long, from Monja Island, near Corregidor, collected by G. A. Lopez; and another, 186 millimeters in length, from Puerto Galera, Mindoro, collected by E. H. Taylor. In both there are about sixty-six scales in a longitudinal and about thirty-eight in a transverse series; none of my specimens therefore agrees with those of Günther, Jordan, and other authors who state that there are sixty scales in a longitudinal series, or with Günther's statement that there are thirty-two scales in a transverse series. In my specimens the head is 3.5 times or a little more or less in the length, while the snout is contained from 4.43 to 4.53 times.

The color in alcohol is very dark or blackish brown, the fins all fading out to white, except the marginal band of black on the soft dorsal and anal, and the first dorsal which remains dark brown; the caudal fin may be yellowish white.

My specimens agree in every essential with the published figures. This balistid, which has not been reported from the Philippines before, occurs throughout the southern Pacific Ocean in all the Polynesian islands, north to the Hawaiian Islands, and west to the Moluccas.

Balistes niger Bonaterre.

Balistes niger BONATERRE, Tabl. Encycl., Ichth. (1788) 19, pl. 85, fig. 152, after Sonnerat. Isle de France.

Balistes conspicillum BLOCH and SCHNEIDER, Syst. Ichth. (1801) 474; LESSON, Voy. Coquille, Zool. 2 (1830) 112, Atlas (1826) Poissons,

pl. 9, fig. 1; SCHLEGEL, Fauna Japonica (1846) 289, pl. 129, fig. 1; BLEEKER, Atlas Ichth. 5 (1865) 116, pl. 221, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 220; DAY, Fishes of India (1878) 689.

Pachynathus conspicillum JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 256.

Dorsal III, 25–26; anal 22–23. Body subelliptical, its depth contained from 1.88 to 2 times, head from 3 to 3.25 times in length; snout but little curved, forming almost a straight line from above eyes to upper lip; about 0.8 as long as head and contained from 3.8 to 4.1 times in length; entire head covered with scales except the lips, which are broad and fleshy, equal or the lower one projecting; the sharp pointed teeth relatively smaller than in many other balistids; anterior end of gill slits below posterior margin of eyes or farther back; eyes of moderate size, 4.5 to 5 times in head, 3.5 to 3.9 times in snout; a patch of about five bony plates behind gill opening; about forty-five or forty-six scales from gill opening to last row of scales on caudal fin, and about thirty-eight scales from origin of the soft dorsal to anus; 2.5 to 3.5 rows of short spines on caudal peduncle; ventral spine broad, movable, and moderately long; the soft dorsal and anal rather low, caudal slightly rounded.

A specimen, 260 millimeters long to base of caudal, or 300 millimeters long over all, collected by me at Bungau, Sulu Province, had the following colors in life: Upper part of head and body black except from above eyes to second dorsal where it was greenish yellow, mottled with irregular lines and black dots; throat white with breast and body behind pectoral covered with large circular white spots, one row extending from pectoral to caudal and two irregular rows below; a broad greenish yellow band extended across forehead to below pupil of each eye; around mouth a broad yellow band, then one of black, then a narrow lavender pinkish line; the spinous dorsal black; the soft dorsal and anal with a bright yellow basal band, then pink, the marginal portion colorless; upper part of caudal peduncle lemon yellow; basal portion of caudal fin black, followed by a broad greenish yellow band, then a black band, with a narrow white edging.

Color in alcohol brownish black to black, with three or four longitudinal rows of very large circular white spots on lower half of body, the first beginning under pectoral fin; in front of pectorals and around throat the spots fuse to form a broad band; a paler portion extends from above eyes to second dorsal and down on sides to level of lower margin of eyes; it

is reddish brown or caused by a network of pale violet-tinged lines forming irregular polygons, each containing a dusky or brown spot on center of each scale, except near first dorsal where they cover more than one scale, the spots forming irregular longitudinal rows; a broadly V-shaped white band on forehead, extending back to below eyes; a bluish line around mouth followed by a broad white band, then a narrow black band, then a bluish or white stripe; a large white patch on caudal peduncle; first dorsal velvety black; soft dorsal and anal each with a white stripe along base, the rest of the fin bluish or pale; base of caudal with a broad blackish brown band, then a wide white band, followed by a narrower black band, with a white line forming posterior margin of fin.

I have examined two specimens, the one named above, and another collected at Cresta de Gallo, by G. A. Lopez. Although not previously reported from the Philippines, it undoubtedly occurs throughout the Archipelago, since it ranges from Madagascar to New Guinea, southeast to the Fiji Islands, and northward in the Kuro-Siwo to southern Japan.

Balistes chrysopterus Schneider.

Balistes chrysopterus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 466; JORDAN and SEALE, Bull. Bur. Fisheries 25 (1905) 362; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272.

Balistes niger MUNGO PARK, Trans. Linn. Soc. 3 (1797) 37; GÜNTHER, Cat. Fishes 8 (1870) 218; DAY, Fishes of India (1878) 688, pl. 181, fig. 1; GÜNTHER, Fische der Südsee 3 (1910) 439; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 99.

Balistes armatus LACÉPÈDE, Hist. Nat., Poiss. 1 (1798) 336, 382, pl. 18, fig. 2; BLEEKER, Atlas Ichth. 5 (1865) 115, pl. 216, fig. 1.

Balistes albicaudatus RÜPPELL, Neue Wirbelt., Fische (1835) 54, pl. 16, fig. 1.

Dorsal III, 27; anal 23. From forty-seven to fifty scales in a longitudinal series from gill slit to base of caudal and twenty-eight to thirty scales in a transverse series from anus to origin of first dorsal.

The compressed body shaped like an elongate pointed ellipse, its greatest depth more than half the length, and contained 1.9 times in length; the elongate head half or nearly half as long as trunk, its profile straight or slightly depressed just forward of eyes; the long thick snout from $\frac{6}{7}$ to $\frac{8}{9}$ as long as head; the rather large eyes placed high up and far back, their posterior margin above or slightly in advance of the lower anterior end of gill slits, and their longest diameter about 0.2

the length of head; behind gill slit half a dozen enlarged bony plates, one of them nearly as large as all the rest together; mouth terminal, small, with thick lips and equal jaws; first dorsal spine short, blunt, and a little more than half as long as head; ventral spine freely movable; seven or eight more or less complete rows of spines on caudal peduncle, their points strongly curved forward.

Color in life of a specimen 165 millimeters long, collected at Jamillo, Batangas, was dark brown, with breast and head from mouth to gill slits bright red; pectoral red; dorsal, anal, and caudal all had a marginal stripe of red, then a wide band of blue, the basal portion dark.

Color in alcohol is brown to blackish brown with breast and cheeks sometimes paler than rest of body; lips yellowish to whitish, with a bluish or dark band encircling them, this followed on lower lip by a white or pale stripe; on chin a white or pale band, which extends more or less backward upon cheeks; membrane of first dorsal chocolate brown, second dorsal and anal pale; the truncate caudal dark brown, with pale or white upper and lower margins and a distinct whitish or milk white half-moon on posterior margin.

This species is here described from the specimen already mentioned and three others, from the following localities: Iba, Zambales, length, 97 millimeters; Monja Island, 146 millimeters; Siasi, 77 millimeters.

The flesh of this little balistid, which is said not to exceed a length of 180 millimeters, is worthless. The fish occurs from the Red Sea, where it is common in the winter months, and Zanzibar, eastward throughout the Indian and Pacific Oceans as far as the Pelew and the Society Islands.

Balistes capistratus Shaw.

Balistes capistratus SHAW, General Zoölogy 5 (1804) 417; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 (1903) (1905) 412, fig. 181; GÜNTHER, Fische der Südsee 3 (1910) 440.

Balistes frenatus BLEEKER, Atlas Ichth. 5 (1865) 114, pl. 223, fig. 2.

Balistes mitis GÜNTHER, Cat. Fishes 8 (1870) 218; DAY, Fishes of India (1878) 689, pl. 177, fig. 3.

Pachynathus capistratum JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 255.

Dorsal III, 27; anal 24. Scales from gill slit to caudal rays, about fifty-two; depth of the rather elongate thick body contained about 2.2 times in length, head 3.2 times; snout nearly straight, its length 3.64 times in head and body, and $\frac{7}{8}$ as

long as head; eyes rather small and close to profile, 0.2 as long as snout and contained 5.7 times in head; head entirely covered with scales up to the thick fleshy equal lips; teeth very uneven; gill slits extend forward of a line from posterior margin of eye; five or six bony plates behind each gill slit, one of them much enlarged; about thirty-four scales in a transverse series from first dorsal to vent; ventral spine short and movable; posterior half of body and caudal peduncle with eight more or less complete rows of small tubercles bearing short sharp spines; soft dorsal and anal low, caudal nearly truncate, short, its length contained 9.5 times in length over all.

Color in alcohol uniform blackish brown, becoming much paler on belly, with concolorous caudal and vertical fins, except margins of soft dorsal and anal, which are pale; lips whitish yellow; a whitish stripe from each angle of mouth toward base of pectoral but stopping short of it; a similar stripe running around chin a short distance from lower lip and connecting the two lateral stripes.

Here described from a specimen 285 millimeters long over all, or 255 millimeters without the caudal fin; it was collected at Jamillo, Batangas; recently two more specimens, obtained at Zamboanga, were added to the Bureau of Science collection. This species has not been previously reported from the Philippines.

This balistid reaches a length of 400 millimeters and occurs from the east coast of Africa to the Hawaiian Islands and the islands of the South Pacific; only two examples have been recorded from Japan, and it is also rare in the South Seas, but is abundant in the East Indies.

Balistes viridescens Bloch and Schneider.

Balistes viridescens BLOCH and SCHNEIDER, Syst. Ichth. (1801) 477; BLEEKER, Atlas Ichth. 5 (1865) 112, pl. 231, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 220; Fische der Südsee 3 (1910) 441; DAY, Fishes of India (1878) 689, pl. 177, fig. 2; WEBER, Fische der Siboga Exp. 57 (1913) 574, pl. 10, fig. 15.

Dorsal III, 24, 25; anal 25. The broad compressed body twice or a little more than twice as long as deep; head contained from 2.8 to 3.1 times in length; the convex snout a trifle more than 0.75 as long as head and contained from 3.7 to 4 times in length; it is covered with scales up to the thick fleshy lips and has no naked places except the fold behind angle of mouth; upper lip projects beyond lower and does not entirely cover the

stout pointed teeth; eyes rather small, and contained from 5 to 6.75 times in head, or from 4 to 5.1 times in snout; several small bony plates behind gill slit, and from eighteen to twenty scales in a transverse row from dorsal fin to anus; twenty-nine or thirty scales in a row from gill opening to caudal fin; ventral spine short to very short and more or less movable; the bony ventral plates broad and thick; on caudal peduncle five or six rows of stout recurved spines; soft dorsal rather elevated, its height half the depth of body beneath, while anal is nearly as high; caudal truncate to rounded.

The color in one alcoholic specimen is uniform brown; in another the body is very dusky except on snout, chin, and breast, which are rosy to whitish; a broad indistinct blackish band across forehead and through eyes to pectorals; a broad blackish band above upper lip, above which is a narrow pale or white stripe; another broad dark band runs from above angle of mouth to a point below eye; a narrow white stripe below lower lip; soft dorsal, anal, and caudal each with a wide dark stripe near margin; first dorsal with large dark spots on membrane.

Here described from two specimens collected at Calapan, Mindoro, 400 and 299 millimeters long; a specimen 215 millimeters long, from Bantayan Island; and another specimen from Estancia, Panay, having a length of 255 millimeters. A specimen from Zamboanga is paler, with a dark spot on the center of each scale and with a wide dark blotch below the soft dorsal. In the University of Santo Tomas Museum is a specimen from Mindoro with a length of 305 millimeters, and one from Manila Bay with a length of 420 millimeters.

Previously recorded from the Philippines by Max Weber, who obtained a specimen 740 millimeters long at Sanguisiapo, Tawitawi. This is the largest species of *Balistes* and is said to reach a length of nearly a meter; those of small or moderate size are sometimes eaten. This fish is known to fishermen in most parts of the Philippines. It is found from the Red Sea and Zanzibar to New Guinea and Ponapé, one of the eastern Caroline Islands.

I also place here seven young specimens, 24 to 28 millimeters in length, collected by E. H. Taylor on the southern coast of Cotabato Province, Mindanao. Although not at all like the adult in color, they agree with Weber's figure of a young specimen. Our specimens have the sides of the body and the head sprinkled with conspicuous dark circular dots; the interorbital space is dark; there is a dark blotch on the membrane and around the

base of the first dorsal; there is a dark blotch under the first half of the soft dorsal and a dark band on the top and sides of the caudal peduncle.

Balistes bursa (Lacépède).

> *Balistes bourse* LACÉPÈDE, Hist. Nat., Poiss. 1 (1798) 335, 375, pl. 7, fig. 1.
>
> *Balistes bursa* BLOCH and SCHNEIDER, Syst. Ichth. (1801) 476; BLEEKER, Atlas Ichth. 5 (1865) 116, pl. 223, fig. 3; GÜNTHER, Cat. Fishes 8 (1870) 219; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23[1] (1903) 410, fig. 180.

Dorsal III, 28; anal 25–26. There are about fifty scales in a longitudinal series from gill slit to base of caudal and twenty-eight to thirty from first dorsal spine to anus.

The depth of the oblong, compressed body is nearly or quite one-half of its length; the deep, compressed, and pointed head contained a trifle more or less than 3 times in length; snout thick and forms $\frac{6}{7}$ or more of length of head; lips thick, jaws equal; eyes high up, very near profile, their diameter contained 4.25 to 4.3 times in head; posterior margin of eye above anterior or lower end of gill slit; length of first dorsal spine from 0.6 to 0.64 of length of head; ventral spine short, broad, and movable; three or four bony plates behind gill opening, one of them as large or nearly as large as all the others; a spinous tubercle on each scale on posterior part of body; these pass into short, stout, sharp-pointed spines below middle of soft dorsal, the spines appressed and pointed forward; tubercles and spines form elevated lines along each row of scales, which extend anteriorly in a reduced form to the region behind pectorals; lateral line more evident in this species than in most; beginning behind upper margin of eye it pursues an irregular course parallel with back as far as posterior part of first dorsal, then descends diagonally to middle of body where it disappears; in this portion there are from twenty-five to twenty-seven tubes. Proceeding forward, the lateral line passes below eye and divides, one branch extending on breast almost to median ventral line, the other curving downward and forward on snout to a point opposite angle of mouth; a branch passes from behind eye and over nape to the line on the other side.

Color in alcohol uniform olive brown, with light buff throat and breast; a dark brown crescent-shaped band passes from below first dorsal spine across posterior margin of eye to base of pectoral; another band of like color passes from below mid-

dle of first dorsal behind gill opening and across base of pectoral; a dark blotch extends from anus to and includes ventral spine.

The above description is based on two small specimens from Calapan, Mindoro, 135 and 101 millimeters in length. The fine yellowish or grayish white line which extends from the angle of the mouth to the anus has faded almost entirely. Another specimen, 110 millimeters long, from the same locality, is delicate pale brown anteriorly, becoming darker posteriorly, the throat and belly nearly white; the lips are yellowish white, surrounded by a bluish stripe; a bluish white line extends from the angle of the mouth nearly to the anus; the margin of the ventral flap is deep chocolate brown; the crescentic brown bands are as in the other specimens.

This species, which has not been hitherto recorded from the Philippines, is easily recognized by the crescentic dark brown bands between the first dorsal and the pectoral, and by the great development of spines on the posterior half of the body. This balistid occurs from the east coast of Africa, Madagascar, and the Red Sea, to the Hawaiian Islands, where it is common about the reefs.

Balistes humilis sp. nov.

Dorsal III, 25–27; anal 23–24. There are forty-five rows of scales from gill opening to caudal; about twenty-six in a transverse series from origin of soft dorsal to anal; depth $1\frac{7}{8}$ to 2, head 2.5 to 2.7 in length; snout 1.6 to 1.7 in head, eye 2.75 to 3 in head, 1.75 in snout; gill opening behind eye and just before or partly beneath first dorsal spine; four large bony plates behind gill opening; dorsal spine longer than snout and with two rows of upturned spinelets on its anterior surface; origin of anal posterior to that of dorsal, base of anal a little shorter than base of dorsal; scales on posterior half of body spinescent with small, slender spines, their tips usually hooked and pointing backward; ventral spine rather short, rough, movable.

Colors in alcohol are as follows: A dusky area from tip of snout back to top of caudal peduncle, including the spinous dorsal and extending in two places upon base of soft dorsal; small circular white spots often present in region just below dorsals; a broad dark band beginning above pectoral and passing diago-

nally downward and forward toward throat; lips whitish; sides and belly pale yellowish brown, more or less inclined to reddish.

Here described from thirty-two specimens, 25 to 32 millimeters in length, collected in March, 1923, on the southern coast of Cotabato Province, Mindanao, by E. H. Taylor. The type is No. 10252, Bureau of Science collection.

This immature fish does not agree with anything known to me, but is apparently nearest *B. niger*. Until additional material is available to show its adult form, its affinities cannot be stated with certainty.

Balistes fuscus Bloch and Schneider.

Balistes fuscus BLOCH and SCHNEIDER (1801) 471; GÜNTHER, Cat. Fishes Brit. Mus. **8** (1870) 222; SEALE, Occ. Papers Bishop Mus. **4** (1906) 73; GÜNTHER, Fische der Südsee **3** (1910) 442, pl. 168.

Balistes coerulescens RÜPPELL, Atlas Reise im Nördl. Afrika, Fische (1828) 32, pl. 7, fig. 2.

Balistes chrysospilos BLEEKER, Atlas Ichth. **5** (1865) 111, pl. 225, fig. 3.

Dorsal III, 26; anal 23; scales in longitudinal series fifty; scales in transverse series twenty-nine.

Depth of the oblong compressed body 1.7 in length; both upper and lower profiles convex, depth of head much greater than its length, which is 2.67 in head and body together; the boldly arched snout 3.5 in length and 1.3 in head; the elongate eye 4.6 in head and 3.5 times in snout, its posterior margin a half diameter before a perpendicular from first dorsal spine; the broad interorbital 3.3 in head; gill slit directly beneath first dorsal spine and longer than base of pectoral which lies immediately below and behind; least depth of caudal peduncle 3.6 in head; first dorsal spine stout, much shorter than anterior soft dorsal rays, its length twice the depth of caudal peduncle or 1.8 in head.

The broad lips thick and fleshy, the upper slightly projecting; behind them is a broad naked space which continues backward over most of the cheeks; this is crossed by five widely spaced and slightly convex rows of small tubercular scales; behind gill slit are three large bony plates; the long broad ventral spine movable; vertical fins rather high with strongly convex margin; anal slightly lunate; scales everywhere rough, but there are no spines or tubercles on those of tail.

Color in alcohol everywhere dark brown except on throat, which is paler; each scale on sides and breast with a large yellow spot, which becomes whitish in the preserving fluid; vertical fins each with many rows of similar spots and dark reticulations and a dark band near base, their margins whitish; caudal dark brown with a whitish posterior margin; pectoral dark brown with a broad whitish margin.

Here described from a fine specimen 235 millimeters long, or 284 millimeters including caudal fin, collected by E. H. Taylor at Tatayan Island on the southern coast of Cotabato Province, Mindanao. This species, which is new to the Philippines, is known from the Red Sea and Mauritius to the Fiji and Society Islands. In life it is said to be one of the most beautiful balistids, the ground color being deep blue with golden dots over the body and fins.

Balistes rivulatus Rüppell.

Balistes rivulatus RÜPPELL, Neue Wirbelt., Fische (1835) 56, pl. 16, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 222, after Rüppell.

Dorsal 26; anal 23. There are about forty-six tube-bearing scales in the very irregular lateral line and fifty-two scales in a longitudinal series from gill slit to base of caudal rays; there are about thirty-eight scales in a transverse series from the origin of soft dorsal to anus.

The depth of the compressed body at origin of first dorsal is 1.56 times, and from origin of second dorsal to anus 1.87 times in length; head large and deep, its length, measured from the lower anterior end of gill slit, contained 2.76 times in head and body together and 1.76 times in greatest depth; eyes high up, less than their own diameter from first dorsal, and 3 times in length of head and 2.8 times in the convex snout, which is contained 1.43 times in head and $3\frac{5}{8}$ times in length; there is a pronounced hump before eyes, and the wide, gently convex interorbital space is a little broader than an eye diameter and contained 2.6 times in head; snout partly naked anteriorly, with very small scales behind the bare portion; scales on cheeks separated by seven naked stripes; lips thick, tumid, corrugated, and equal; first dorsal spine rough, blunt, backward-curved, and short, its length 1.9 in head; gill slit slightly oblique, entirely posterior to eye, its lower end opposite upper end of base of pectoral, its length $\frac{5}{7}$ of eye, and with two enlarged

bony plates behind it; ventral spine rough and movable, and ventral flap margined by very slender sharp spines; soft dorsal and anal as high as dorsal spine, with rounded outlines, highest anteriorly; caudal peduncle narrow, its depth less than eye; caudal fin broad, with convex tip, its length a little more than height of dorsal spine; scales small, those on posterior half of body with a central rough tubercle; no spines on caudal peduncle; the well-developed lateral line begins behind upper half of eye, passes upward toward third dorsal spine, and then curves downward toward middle of anal, stopping at level of lower margins of caudal peduncle, then curving upward it passes along middle of caudal peduncle to base of caudal; one branch of the lateral line curves downward under eye and forward on cheek halfway between eye and mouth, then curving downward and forward it passes to angle of mouth; another branch leaves this just below eye and passes downward in front of pectoral, curving backward to a point below pectoral base, and then curves downward and forward, terminating low down on breast; another branch passes over in front of first dorsal and joins the lateral line on the other side.

Color in alcohol dull gray, everywhere marked with irregular, narrow, very dark bluish stripes, longitudinal on body, diagonal on sides of head, and broken on snout, throat, and breast; a broad bluish band between eyes; a small semicircular dark bluish spot below the spinous dorsal and a large dark bluish semicircular spot below anterior half of second dorsal; a dark bluish band encircles caudal peduncle; membrane of first dorsal black; soft dorsal has three, anal two parallel longitudinal bluish lines and rows of spots, and whitish margins; caudal bluish with crossbands and spots of blue; pectoral whitish. The ground color in life is said to be lemon yellow, with azure blue lines and stripes.

Here described from a specimen 58 millimeters long (70 millimeters long with the caudal fin), collected at Laiya, Batangas, in December, 1922. This handsome balistid was collected by Rüppell at Djetta, Arabia, on the Red Sea, nearly a hundred years ago. According to him, it reaches a length of "6½ inches," and was not particularly common. According to Günther, this is the young of *B. fuscus*. My specimen is exactly like Rüppell's excellent figure.

Balistes flavimarginatus Rüppell.

Balistes flavimarginatus RÜPPELL, Atlas Reise Nördl. Afrika, Fische des Rothen Meers (1828) 33; Neue Wirbelt. (1835–40) 54, pl. 15, figs. 1 and 2; BLEEKER, Atlas Ichth. **5** (1865) 113, pl. 218, fig. 3 (juv.); pl. 224, fig. 3 (aet. provect);[8] GÜNTHER, Cat. Fishes **8** (1870) 223; Fische der Südsee **3** (1910) 443 (as *flavomarginatus*); DAY, Fishes of India (1878) 690, pl. 178, fig. 1; EVERMANN and SEALE, Bull. Bur. Fisheries **26** (1906) 99; JORDAN and RICHARDSON, Bull. Bur. Fisheries **27** (1907) 272. The correct form is *flavomarginatus*, but the original one, used by Rüppel, is followed.

Pseudobalistes flavimarginatus JORDAN and FOWLER, Proc. U. S. Nat. Mus. **25** (1902) 257.

Dorsal III, 26; anal 24–25. Scales in lateral line about thirty-five or thirty-six. The depth of the broad, thick body from 1.7 to 2.2 in length, young specimens deeper proportionately than larger ones; head contained from 3.1 to $3\frac{1}{3}$ times in length, its upper profile strongly convex; lips full, broad, fleshy, and in large specimens the upper one projects beyond the lower; teeth strong, the two median ones above large, conical, coarse, projecting; front of snout nearly naked, having but a few rudimentary scales; cheeks well covered with large scales in the young, but in old specimens they are only partly covered; snout contained from 3.6 to 3.9 in length and from 80 to 91 per cent of length of head; anterior or lower end of gill openings beneath eyes or just posterior to their hind margin, so that snout is nearly as long as head; eyes contained from 3.8 to 5.1 times in head and from 3 to 4.9 in snout; three or four bony plates behind each gill opening; from twenty to twenty-two scales in a transverse series from dorsal fin to anus; soft dorsal and anal fins rather high. The caudal varies much in shape with age; in the very young it is rounded and in those of moderate size it is truncate; in large old specimens the tail fin is deeply lunate with prolonged marginal lobes, and forms a fourth or more of the total length over all. Ventral spine short, movable, pelvic bone broad and prominent. There are five or six rows of small recurved spines on caudal peduncle in our specimens, their number and arrangement variable.

Color in alcohol nearly uniform brownish, snout, chin, and throat pale to yellowish or light buff, each scale with a large central dark spot; soft dorsal and anal with a yellowish margin and a broad dark band along middle; caudal with a narrow

[8] The scales on the snout in the latter figure are not correctly drawn. The text reads *flavomarginatus*.

yellow margin followed alternately by a dark band, then another yellow stripe, and a second dark band.

In a large adult specimen the snout was more or less orange, the chin, throat, and breast nearly white, the rest of the body nearly uniform brown, without spots. Caudal, soft dorsal, and anal with yellow (white in alcohol) margin, followed by bands of dark brown, yellow (white), dark brown, and light brown; pectoral dark brown with a pale margin.

Here described from five alcoholic specimens ranging in length from 144 to 410 millimeters, from Calapan, Mindoro, and the reefs at the mouth of Manila Bay. I have also examined specimens from Cebu and Zamboanga. Our largest specimen, from Monja Island, has a length over all of 515 millimeters.

In the Bureau of Science Aquarium are a number of living specimens from Calapan, Mindoro. One of them is bluish gray, with a dark spot on each scale; the snout, chin, and breast are orange, as are also the cheeks except for a dark area below the eyes, which is of the general body color; the pectoral is orange, while the soft dorsal, anal, and caudal are orange with a rather wide bluish band near the outer margin; the one on the caudal is more or less crescent-shaped.

Some of these fishes are more or less olive green in life, while others are pale muddy yellow with the darker parts reddish brown.

This is a common species of the coral reefs; it reaches a length of more than 600 millimeters and is sometimes seen in the fish markets. Its flesh is not only of a very poor flavor but is also dangerous to eat. This species was originally described from the Red Sea; it ranges throughout the East Indies, northward to Japan, and southeastward at least as far as Samoa.

Genus **BALISTAPUS** Tilesius

Balistapus TILESIUS, Mém. Acad. Sci. St. Pétersb. 7 (1820) 302.

This genus is separated from *Balistes*, to which it is closely related, by the absence of a groove in front of the eyes. The head and body are closely scaled, while the posterior parts are covered with more or less spinous scales. The lateral line is obsolete and there is a group of enlarged scales or bony plates behind the gill opening.

These small and brightly colored balistids are common in the tropical waters of the Indian and Pacific Oceans, to which they

seem to be confined. Four of the six or seven species known have been recorded from the Philippines.

Key to the Philippine species of Balistapus.

a^1. No black patch on caudal peduncle; sides dark with four pearly diagonal bands from middle of trunk to anal .... B. aculeatus.

a^2. A black patch or ring on caudal peduncle.

  b^1. Body covered with diagonal, often undulating, narrow stripes; patch on caudal peduncle circular .... B. undulatus.

  b^2. Body without numerous diagonal stripes.

    c^1. A black wedge-shaped patch on caudal peduncle, the point directed forward; a wide blackish band from eye and base of pectoral to vent and base of anal fin .... B. rectangulus.

    c^2. A dark band on caudal peduncle, bordered by broad pale bands; a very large blackish blotch from middle of body down to anal region .... B. verrucosus.

Balistapus aculeatus (Linnæus).

Balistes aculeatus LINNÆUS, Syst. Nat. ed. 10 (1758) 328; BENNETT in Beechey's Voy., Zool. (1839) 69, pl. 22, fig. 2; BLEEKER, Atlas Ichth. 5 (1865) 120, pl. 216, fig. 3; GÜNTHER, Cat. Fishes 8 (1870) 223; DAY, Fishes of India (1878) 690, pl. 178, fig. 3.

Balistapus aculeatus JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) (1903) 259; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 (1903) (1905) 414, pl. 62; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 100; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272; WEBER, Fische der Siboga Exp. (1913) 576.

Balistes ornatissimus LESSON, Voy. Coquille, Zool. 2 (1830) 119; Atlas (1826) Poiss., pl. 10, fig. 1.

Dorsal III, 24–25; anal 21–22. There are forty scales in a longitudinal series from gill slit to base of caudal rays, and twenty-five (twenty-three to twenty-four, auctt.) in a transverse series from base of first dorsal spine to anus.

Body compressed, elongate-ellipsoid, its depth contained from 2 to nearly 2.5 times in length; the large, pointed head contained from 2.6 to 2.85 times in length; eyes placed very high up and almost at posterior extremity of head, in which they are contained from 5 to 5.6 times; the long thick snout just $\frac{1}{3}$ of length from its tip to base of caudal fin; lips thick and equal; from three to five enlarged bony plates behind gill slits, one of them nearly as large as all the rest together; length of the short, broad, blunt-tipped first dorsal spine less than half that of head; on caudal peduncle are two and a half rows of sharp recurved spines.

Color in alcohol varies from grayish to pale brown above; throat and belly pale to white; beginning behind gill opening and extending to caudal peduncle is a large ragged-edged dark

brown spot; from upper side of spot a band extends upward and backward to origin of soft dorsal, while from lower side five bands of greatly varying width extend diagonally backward, the first to anus, the next three to anal fin, and the last behind anal fin; between them are two pairs of bright pearl-white bands extending from middle of side diagonally to anal fin; a bluish band crosses over behind upper lip from one angle of mouth to the other; behind it is a yellow band which extends backward from angle of mouth to base of pectoral; a bluish patch between eyes is crossed by three narrower brown stripes; below eye three bluish stripes extend to base of pectoral; the blackish spines on caudal peduncle are upon a pearl-white patch; spinous dorsal brown, the other fins pale yellowish.

I have examined eleven alcoholic specimens, ranging in length from 35 to 151 millimeters, from the following localities: Puerto Galera and Calapan, Mindoro; Bacon, Sorsogon; Zamboanga; Samal Island; Guam. It has also been recorded from Cuyo by Jordan and Richardson and from Bacon and Zamboanga by Evermann and Seale; Weber collected it at Sanguisiapo. In the University of Santo Tomas Museum is a specimen labeled "N. de Luzon."

This handsomely colored fish, which well deserves Lesson's name "tres orné," is common about the coral reefs from the western part of the Indian Ocean eastward throughout Polynesia, including the Hawaiian Islands, and north to Marcus Island and the Riu Kiu Islands.

Balistapus undulatus (Park). Plate 1, fig. 1.

Balistes undulatus PARK, Trans. Linn. Soc. 3 (1797) 37; GÜNTHER, Cat. Fishes 8 (1870) 226; DAY, Fishes of India (1878) 691, pl. 177, fig. 4; WEBER, Fische der Siboga Exp. (1913) 575.

Balistapus undulatus JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 35; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 100; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 273.

Balistes lamouroux QUOY and GAIMARD, Voy. Uranie, Zool. 2 ͤ part. (1824) 208, pl. 47, fig. 1.

Balistes sesquilineatus BENNETT in Beechey's Voy., Zool. (1839) 69, pl. 21, fig. 3.

Balistes (Balistapus) lineatus BLEEKER, Atlas Ichth. 5 (1865) 118, pl. 229, fig. 2.

Balistapus lineatus FOWLER and BEAN, Proc. U. S. Nat. Mus. 62 (1922) 59.

Dorsal III, 24–26; anal 23–24. There are from thirty-seven to forty-two scales in a longitudinal series from gill slit to base of caudal rays and from twenty-six to thirty in a series between base of first dorsal spine and anus.

Depth contained from 1.9 to 2.2 times in length; head very deep, its length 3 to 3.2 times in length; eyes high up and far back, being very close to posterior extremity of head, in which they are contained 4.8 to 5 times; the thick, slightly concave snout 4 times or a little more than 4 times as long as eye diameter; lips fleshy and jaws equal; behind each gill slit is a patch of from four to six enlarged bony plates; on caudal peduncle are six or eight stout to very long and strong spines in two rows.

The color in alcohol varies from light brown to nearly black, with yellow or pale fins, except the spinous dorsal which is dusky, with a broad black margin on anterior part. Head and body covered with diagonal stripes, usually pale, yellow, orange, or whitish, which pass from dorsal surface to anal and caudal; several also pass from about mouth and chin and unite posteriorly to form a broader stripe which extends back to below pectoral; under chin is a black stripe which stops below pectoral; there is a circular black patch on caudal peduncle in which are the caudal spines; there is a narrow dark band along base of second dorsal and anal fins.

I have examined thirteen alcoholic specimens, varying in length from 65 to 170 millimeters, collected in the following localities: Iba, Zambales; Calapan and Puerto Galera, Mindoro; Cabalian, Leyte; Puerto Princesa, Palawan; Balabac; Samal Island, Mindanao; and Sitanki.

This species has been previously recorded from Cavite by Jordan and Seale; from Cagayancillo by Jordan and Richardson; from Bacon, Sorsogon, by Evermann and Seale; from Sanguisiapo in the Tawitawi group by Weber; and from Zamboanga by Fowler and Bean.

This balistid, which reaches a length of more than 300 millimeters, is very abundant about coral reefs in the Indian and Pacific Oceans, and ranges from the Red Sea and Mozambique east and north to the coast of China, the Riu Kiu Islands (?), Guam, and the Society Islands.

Balistapus rectangulus (Bloch and Schneider).

Balistes rectangulus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 465; GÜNTHER, Cat. Fishes 8 (1870) 225; DAY, Fishes of India (1878) 691, pl. 178, fig. 2.

Balistapus rectangulus FOWLER, Proc. Phil. Acad. Nat. Sci. (1900) 514; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 (1903) 413, pl. 63; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 273.

Balistes medinilla QUOY and GAIMARD, Voy. Uranie, Zool., 2^{e} part. (1824) 206, pl. 46, fig. 2.

Balistes erythropteron LESSON, Voy. Coquille, Zool. 2 (1830) 123, Atlas (1826) Poiss. No. 210, fig. 3.

Balistes cinctus BLEEKER, Atlas Ichth. 5 (1865) 119, pl. 228, fig. 1.

Dorsal III, 24; anal 21. There are about forty scales in a longitudinal series from gill slit to base of caudal fin and about thirty in a transverse series from first dorsal spine to anus.

Depth a trifle more than half of length, and head contained 2.58 times in length; snout contained 1.4 times in head and is 2.2 times as long as eye; the blunt, stout first dorsal spine about half as long as head; three enlarged plates behind gill slit; eye placed very high up, almost flush with profile, and about half its diameter in advance of dorsal spine, which is over gill opening; on caudal peduncle are four rows of short recurved spines.

Snout and dorsal surface dusky, belly whitish; a dark interorbital band, which becomes blackish brown below eye, passes diagonally to base of pectoral; from gill slit and base of pectoral a very broad blackish brown band goes diagonally downward to anus and anterior three-fourths of anal fin; on caudal peduncle the acute angle of a black wedge-shaped band extends forward to a point opposite anterior third of soft dorsal and anal fins; paler above and below the dark wedge; first dorsal fin dark, the other fins all pale.

I have examined a specimen of this boldly marked species, 40 millimeters long, which was obtained at Cabalian, Leyte. It was previously collected by R. C. McGregor at Calayan Island, north of Luzon, as recorded by Jordan and Richardson.

This species is not very abundant in the East Indies, but occurs from the east coast of Africa throughout Polynesia, where it is common. Northward it ranges to Marcus Island and Honolulu.

Balistapus verrucosus (Linnæus).

Balistes verrucosus LINNÆUS, Mus. Ad. Frid. (1754) 57, pl. 27, fig. 4; Syst. Nat. ed. 10, 1 (1758) 328; BLEEKER, Atlas Ichth. 5 (1865) 120, pl. 216, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 225; Fische der Südsee 3 (1910) 444, pl. 170, fig. A.

Balistapus verrucosus JORDAN and RICHARDSON, Bull. U. S. Bur. Fisheries 27 (1907) 273.

Balistes praslinensis QUOY and GAIMARD, Voy. Uranie, Zool., 2^{e} part. (1824) 205, pl. 46, fig. 1.

Balistes praslinoides LESSON, Voy. Coquille, Zool. 2 (1830) 117, Atlas (1826) Poiss. No. 9, fig. 3.

Local name: *Pugut gusu,* Tao Sug.

Dorsal III, 17–26; anal 22, 23. In a longitudinal series from gill slit to base of caudal rays there are from forty to forty-three scales, and in a transverse series from first dorsal spine to anus there are from twenty-four to twenty-five scales.

Depth contained about twice in length, while head is contained 2.6 to 2.75 times; snout about $\frac{1}{8}$ the length and about $\frac{7}{8}$ of length of head; eye, which is contained 4.3 to 5.3 times in head, is placed very high up, with its posterior margin nearly a diameter in advance of first dorsal spine and directly above lower or anterior end of gill slit; first dorsal spine broad, blunt, and quite variable in length, but when normally developed equal to half the length of head; there are three and a half rows of sharp, appressed spines, their points directed forward; behind gill slits are three or four enlarged bony plates; the very irregular lateral line is readily visible.

Upper half of alcoholic specimens varies from pale brown to blackish brown, underparts pale brown to white, with a very large black blotch extending from middle of side to anal region; above upper lip is a broad blackish or pale bluish band which extends backward from behind angle of mouth a short distance; above it is a narrow pale line which extends to base of pectoral; three wide dark bands upon interorbital space; in some they are bordered by narrow blue lines; the middle one descends from eye to base of pectoral, widest above and narrowing below; sometimes it has a central and two marginal blue lines; caudal peduncle pale with a black band extending downward from posterior end of soft dorsal, but not reaching anal; a black line on upper half of narrowest part of caudal peduncle, and a black band at posterior extremity of caudal peduncle across base of fin; caudal spines black; first dorsal spine very dark, rest of first dorsal and the other fins all pale or yellowish.

I have examined eight specimens from Iba, Zambales; Calapan, Mindoro; Cabasao, Camarines; Cabalian, Leyte; Zamboanga, Mindanao; and Jolo, varying in length from 33 to 110 millimeters. It has previously been recorded by Günther from the "Philippine Islands" and from "Zebu;" by Jordan and Richardson from Cagayancillo Island; and by Seale and Bean from Zamboanga. In my specimens from Zamboanga, which are 33 and 35 millimeters long, the proportions are different from those given, owing to the greater relative size of the eye. In the University of Santo Tomas Museum is a specimen about 170 millimeters long, labeled "N. de Luzon."

This variable but distinctly marked and easily recognized species is very common in the East Indies and ranges north to the Pelew Islands, and southeast to the Society Islands.

Tao Sug is the kind of Moro spoken by the people on Jolo Island.

Genus **ABALISTES** Jordan and Seale

Abalistes JORDAN and SEALE, Bull. Bur. Fisheries 25 (1906) 364.
Leiurus SWAINSON, Nat. Hist., Fishes 2 (1839) 326.

This well-marked genus is separated at once from all other Balistidæ by the peculiar caudal peduncle, which is thick and strongly flattened on the top and bottom, so that at the narrowest part its depth is much less than its breadth. The first dorsal spine is also longer, slenderer, and more pointed than in other Philippine Balistidæ. In other respects it agrees fairly well with *Balistes*.

Swainson's name cannot be used, as it is preocupied.

Abalistes stellaris (Bloch and Schneider).

Balistes stellaris BLOCH and SCHNEIDER, Syst. Ichth. (1801) 476.
Leiurus stellatus BLEEKER, Atlas Ichth. 5 (1865) 105, pl. 215.
Balistes stellatus GÜNTHER, Cat. Fishes 8 (1870) 212.

Dorsal III, 27; anal 24 or 25. There are about forty-five scales in a longitudinal series and twenty-nine in a transverse series from first dorsal spine to anus.

Depth contained 2.35 to 2.5 times, head nearly 3.5 times in length; the convex snout from 0.75 to 0.8 of length of head and contained 4.3 times in length; the rather large eyes placed very high up and contained 4.4 to 4.5 times in head; the long, narrow, sharp-pointed first dorsal spine 3.75 times diameter of eye and slightly exceeds length of snout in one specimen; in others it is 3 times eye and a little more than 0.9 as long as snout; mouth terminal, with equal jaws and thick, fleshy lips; the central pair of teeth both above and below longer than the rest; gill slit beneath first dorsal spine, and behind it are five or six enlarged bony plates; ventral spine broad, stiff, and in one specimen immovable; in the others it is flexible; caudal peduncle strongly compressed dorsoventrally, the upper and lower surfaces broad and flat; depth of caudal peduncle at narrowest part from 0.6 to $\frac{5}{6}$ of its lateral diameter; five rows of scales on posterior half of trunk and on caudal peduncle more or less keeled; posterior margin of caudal somewhat wavy and the lobes produced into long filaments.

Color in alcohol pale bluish gray, gradually merging into white on belly; dorsal region may be more or less pale brown; there are few distinct markings; there are traces of large circular white spots on back; both dorsals, anal, and caudal are variously marked with alternate bands, stripes, or reticulations of white and bluish or brown.

Here described from a very poor specimen, 316 millimeters long, collected at Malampaya Sound in 1910 by W. Cameron Forbes, and from two fine specimens, 282 and 220 millimeters in length, collected at Basilan, August, 1923, by G. A. Lopez.

A very fine specimen, 250 millimeters long, has also been added to the collection from Estancia, Panay.

Young specimens are marked with more or less irregular blue lines on head, tail, and the region between pectoral and first dorsal, while on back are four large white spots. These spots and markings largely or entirely disappear in adult life.

This fine balistid, which reaches a length of more than 600 millimeters, has not been reported previously from the Philippines. It occurs from the Red Sea and the coast of Mozambique to the Fiji Islands.

Genus **MELICHTHYS** Swainson

Melichthys SWAINSON, Nat. Hist., Fishes 2 (1839) 325.

This genus is chiefly distinguished by having white, even, incisorlike teeth instead of the irregular pointed or notched teeth of *Balistes*. There is a groove before the eye, and the head is entirely covered with scales. The ventral flap is small, immovable, and covered with rough scales.

There is apparently but a single species, widely dispersed in the Indian and Pacific Oceans and also in the West Indies.

Melichthys radula (Solander).

Balistes radula SOLANDER, MSS. (1768) in Richardson, Voy Samarang, Fishes (1848) 21, pl. 6, figs. 1–4.
Balistes ringens OSBECK, Reise nach Ostind. (1765) 386, not of Linnæus.
Melichthys ringens BLEEKER, Atlas Ichth. 5 (1865) 108, pl. 220, fig. 2.
Balistes niger GÜNTHER, Fishes of Zanzibar (1866) 135, pl. 19, fig. 1.
Balistes buniva GÜNTHER, Cat. Fishes 8 (1870) 227.
Melichthys bispinosus GILBERT, Proc. U. S. Nat. Mus. 13 (1890) 125.
Melichthys radula JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 (1903) 417, pl. 64.

Dorsal II, 31; anal 27. There are sixty-one scales in a longitudinal series from gill slit to base of caudal rays and thirty-nine in a transverse series from first dorsal spine to anus.

Depth a trifle more than twice in length; head very deep, with projecting lower jaw, its length contained a little more than 1.5 times in its depth and 3.6 times in head and body together; snout convex, its length 1.3 times in head and 4.8 times in length; eye anterior to gill opening and contained 4.5 times in snout or about 6 times in head; gill slit slightly in advance of the wide, thick, blunt first dorsal spine, which is not serrate and is contained 1.7 times in head; four enlarged bony plates behind gill slit; eight rows of short sharp-pointed spines on sides, extending from middle of trunk back to posterior portion of caudal peduncle; caudal fin lunate, upper and lower lobes being moderately elongated.

This fish seems to be subject to variation in the number of dorsal spines and dorsal and anal fin rays. The first dorsal may have either two or three spines; the second may have from thirty-one to thirty-three rays, and the anal from twenty-seven to thirty.

Color in alcohol uniform deep black with very dark brown fins, and a white line on base of soft dorsal and anal fins; a very fine pale line parallel to and near posterior margin of caudal fin.

Here described from a specimen 283 millimeters long, without the deeply lunate caudal fin, collected by G. A. Lopez at Sibuyan. This species, which has not hitherto been recorded from the Philippines, is found in the Indian Ocean, from the Seychelles eastward throughout the tropical Pacific to the Revillagigedo Islands off the coast of Mexico. It is apparently rare in the Indian Ocean and the East Indies, but is very abundant at Marcus Island and the Revillagigedos, and is common at Honolulu. This is one of the most widely distributed coral-reef fishes and occurs also in the West Indies, where it is not very common. The *ringens* of Linnæus belongs to the genus *Xanthichthys*.

Genus **ODONUS** Gistel

Odonus GISTEL, Naturgesch. des Thierreichs (1848) XI.

This genus is differentiated from the other Balistidæ by the orange or red teeth, the two long and strongly projecting canines of the upper jaw, the large prominent chin, the large scales on the sides of the body, and the greatly prolonged caudal lobes. There is a groove in front of the eye, as in *Balistes*.

The genus was first recognized in 1835 by Rüppell, who called it *Xenodon*, a name preoccupied in reptiles. Swainson's misprint

of it in 1839 as *Zenodon* cannot be accepted as a valid substitute, while Rüppell's appropriate name of *Erythrodon*, proposed in 1852, is preceded by *Odonus*.

Odonus niger (Rüppell). Plate 1, fig. 2.

Balistes niger (*Baliste noir*) LACÉPÈDE, Hist. Nat., Poiss. 1 (1798) 335, 378, pl. 15, fig. 2.

Xenodon niger RÜPPELL, Neue Wirbelt., Fische (1835) 53, pl. 14, fig. 3.

Erythrodon niger RÜPPELL, Verzeich. Mus. Senck., Fische (1852) 34; BLEEKER, Atlas Ichth. 5 (1865) 106, pl. 219.

Balistes erythrodon GÜNTHER, Cat. Fishes 8 (1870) 228; DAY, Fishes of India (1878) 692, pl. 175, fig. 4.

Dorsal III, 32, 35; anal 28, 30. There are from thirty-three to thirty-five scales in a longitudinal series from gill slit to base of caudal fin and about twenty-two in a transverse series from first dorsal spine to anus.

Depth of the broadly ellipsoid body is half its length; head contained from 3.7 to 4 times in length, snout from 0.75 to 0.8 as long as head; eyes of medium size, their posterior margin slightly in advance of gill slit, in one specimen contained 3.6 times in head, in larger specimens from 5.4 to 5.8 times; first dorsal spine short, broad, and blunt, its length from 1.8 to 1.9 in head or from 2 to 3 times diameter of eye; three enlarged bony plates behind gill slit.

The rounded prominent chin extends considerably beyond mouth; teeth red, irregular, upper jaw with a pair of strongly projecting canines which overlie lower lip and are much longer than the pair of central incisors between them; scales on sides of body noticeably large, those on posterior half of body and caudal peduncle more or less keeled or spinous tuberculate, in about seven longitudinal rows; soft dorsal and anal elevated anteriorly, anterior margin convex; upper and lower marginal lobes of the deeply lunate caudal greatly produced, length of caudal proper but 0.2 of that of the elongated caudal filaments.

The color in life of a specimen 173 millimeters long, obtained by Alvin Seale at Sitanki in 1908, was a beautiful uniform deep blue, the soft dorsal and anal darker, approaching violet, with a violet longitudinal band along base; the membrane of first dorsal was brownish orange, the caudal sky blue.

This specimen, after being fourteen years in alcohol, is nearly uniform brownish, with a very narrow whitish line along posterior margin of caudal fin.

Two specimens obtained in 1921 near Olongapo, 241 and 261 millimeters in length, respectively, are uniform blue-black, with blue caudal fin; the free tips of the soft dorsal and anal rays are paler than the body of the fins; a very narrow white line forms the posterior margin of the caudal.

The specimens listed above are the first recorded from the Philippines. This well-marked species, easily recognizable at first glance, is found from the Red Sea, Mombasa, and Ile de Réunion, to the Society Islands in the South Pacific, though it does not seem to be abundant anywhere.

The name at Sitanki is *epet.*

MONACANTHIDÆ

FILEFISHES: FOOLFISHES

This family is closely related to the Balistidæ, but differs fundamentally in having the first dorsal reduced to a single spine. The species are only moderately numerous and are mostly small herbivorous fishes of the coasts of tropical seas, though two of the genera contain rather large fishes which are found in all warm seas. Like the Balistidæ, the Monacanthidæ should not be used for food, as their flesh is not only thin, hard, and more or less bitter, but usually also contains poisonous alkaloids which cause ciguatera and death, if much is eaten.

The body is laterally much compressed, and the tough skin is covered with small to minute scales which are more or less spine-bearing, so that it is usually like fine sandpaper or very fine emery paper to the touch; hence the name filefish. Some of the species are dimorphic, the sexes being quite different in external appearance, and the males sometimes with bunches of long needlelike or stout spines on the caudal peduncle. The first dorsal is composed of a single strong spine, which may have a rudimentary one behind it; the second dorsal and anal are both long and of similar outline; the ventral fins are reduced to a single small bony appendage at the end of the long pelvic bone, which may be either fixed or movable, but may often be rudimentary or entirely absent; the vertebræ are 7 + 11 to 14, or a total of 18 to 21.

The mouth is small, with six incisorlike and often irregular teeth in each jaw, those of the lower jaw fitting inside the upper teeth when the mouth is closed. I cannot agree with authors who state that the upper jaw has a double series of

teeth; upon extracting a tooth I find it to have an inner lamina or cusp with a grinding surface, as in the Balistidæ, but this is an integral part of the tooth; there is, therefore, a single row of teeth in the upper row, some of which appear like two teeth on a cursory examination. Six genera and twelve species of this family are here recorded from the Philippines.

Key to the Philippine genera of Monacanthidæ.

a^1. Dorsal spine over eye.
  b^1. Pubic bone with a small spine at its tip; gill opening short, nearly vertical; dorsal and anal moderate in length, each with less than forty rays.
    c^1. Snout not greatly elongated, without tubular tip.
      d^1. Ventral spine jointed, movable; dorsal spine armed with barbs.
        e^1. Abdomen with a wide thin finlike flap with branched supporting rays and extending far beyond pelvic spine.. **Monacanthus.**
        e^2. Ventral flap little developed, not finlike................ **Stephanolepis.**
      d^2. Ventral spine immovable; dorsal spine with or without barbs. **Cantherines.**
    c^2. Snout greatly elongated, with tubular tip.............. **Oxymonacanthus.**
  b^2. No ventral spine; gill opening long, very oblique; dorsal and anal long, each with forty-five or more rays.
    f^1. Caudal fin nearly truncate, shorter than head; snout convex. **Alutera.**
    f^2. Caudal fin very long, with rounded angles; snout concave. **Osbeckia.**
a^2. Dorsal spine on snout forward of eye, gill opening behind eye. **Pseudaluteres.**

Genus **MONACANTHUS** Cuvier

Monacanthus CUVIER, Regne Anim. ed. 1 (1817) 152.

This genus includes several species of small or medium-sized fishes found in the tropical and warm temperate seas. All have a short, deep, and very strongly compressed body, the leathery skin covered with minute but rough scales, often reduced to shagreenlike prickles, and the lean, hard, bitter flesh is unfit for food. The mouth is very small, the snout longer than the head, its profile more or less concave; the gill opening is a small slit directly beneath the circular eye, its anterior or lower end just in front of the upper edge of the pectoral. The large dorsal spine is without conspicuous filaments, but has two rows of stout, hooked, downward-pointing barbs on the rear and may or may not have two closely set rows of much smaller barbs on the front side. The soft dorsal and anal are alike, of twenty-five to thirty-five rays each; the caudal fin is of moderate size, its free end rounded; the pelvic bone ends in a blunt, movable

spine and is connected to the abdomen by a very large, wide, movable flap or dewlap which extends like a fin far beyond the body line, and is supported by branched flexible rays resembling fin rays; spines are often present on the sides of the caudal peduncle, especially in males. The vertebræ are 7 + 11 to 14, a total of 18 to 21. Only one species is known from the Philippines.

Monacanthus chinensis (Bloch). Plate 1, fig. 3.

Balistes chinensis BLOCH, Ichth. 5 (1787) 26, pl. 152, fig. 1; OSBECK, Iter Chinensis (1757) 147.

Monacanthus chinensis BLEEKER, Atlas Ichth. 5 (1865) 125, pl. 222, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 236; JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 262.

Dorsal I, 29; anal 29. This exceedingly deep and compressed fish is distinguished at a glance by the peculiar form of the body with its great ventral flap like a huge pendulous dewlap, and by its distinctive coloration. The depth at the origin of the soft dorsal is contained 1.85 times in length, and the depth measured at its greatest extent is contained about 1.25 times in length; the small, pointed, rather short head is contained 4 times in length and both snout and throat are concave; snout more than 0.8 as long as head; eyes high up, their diameter about $\frac{1}{3}$ of snout and 3.68 times in head; interorbital space very high and convex; mouth small, and opposite upper part of gill opening; lips smooth and rather broad, with chin slightly projecting; the moderately stout and rather short dorsal spine armed behind with two rows of strong recurved spines and inserted over posterior half of eye, its length 1.6 times in head; gill slit about 0.25 longer than an eye diameter and extending diagonally upward and backward from in front of upper part of pectoral to a point slightly posterior of hind margin of eye; soft dorsal and anal both well developed, the middle rays longest, those of anal reaching a length approximately $\frac{2}{3}$ that of head; length of caudal equal to that of head, first or upper ray elongated, the free margin convex; when expanded caudal very broad, its length contained $1\frac{5}{9}$ in its depth; abdomen developed into a very wide, thin flap which extends below body contour proper much farther than do the anal rays; this flap is supported by many long, slender, cartilaginous stays which look like fin rays; ventral spine long, jointed, and movable; ventral region above the finlike portion very roughly striated with tubercular lines and ridges; caudal peduncle very rough

and on each side it has two rows of large spines curved forward, with three in each row; body everywhere covered with very small spinescent scales, so that it feels like rough sandpaper.

Color in alcohol light brown, mottled and irregularly banded with dark brown; at least two wide irregular bands pass diagonally forward from soft dorsal to ventral side; entire body sprinkled with dark or blackish brown dots; six longitudinal rows of very small dark spots on soft dorsal and a polygonal network of dark lines on anal; a similar network, more or less broken into spots, on outer portion of finlike ventral expansion; caudal has a wide basal blackish band, then a very wide paler band, then another band of blackish brown, and a pale margin; the whole fin marked by narrow transverse lines of dark brown and everywhere sprinkled with fine dark dots; the pectoral colorless.

Here described from a specimen 185 millimeters long, or 230 millimeters in total length, collected at Culion Island. I have also examined thirteen other specimens, varying in length from 22 to 170 millimeters, collected at Bulan, Sorsogon; Bantayan Island; Zamboanga and Davao, Mindanao; Balabac Island; and Sandakan, Borneo. Several of these specimens lack spines on the caudal peduncle. Three specimens from Davao are very small, being only 22 to 25 millimeters long, and are quite unlike other specimens in their proportions; the most conspicuous difference is in their depth, which is nearly or quite equal to their length; their coloration is not very distinctive, but the two large diagonal dark bands can be made out and the whole body is conspicuously though sparsely sprinkled with large dark dots. The caudal peduncle in these three specimens has a patch of very long stiff bristles directly in front of the caudal fin, their free tips extending upon the fin; this character is evidently soon lost, for in one of these juvenile specimens one side has already lost the bristly hairs and has the characteristic spines, though of course they are still very small.

This species has been recorded from Manila and from Negros Island by Jordan and Seale, and from Bulan, Sorsogon, by Evermann and Seale, and undoubtedly occurs around reefs in all parts of the Philippines. It is common on the shores of the China Sea and the Malay Peninsula, and occurs from Pinang and Singapore eastward to Celebes and the Moluccas, and north to the Riu Kiu Islands.

There are two specimens from northern Luzon in the University of Santo Tomas Museum.

Genus STEPHANOLEPIS Gill

Stephanolepis GILL, Proc. Acad. Nat. Sci. Philadelphia (1861) 78.

In *Stephanolepis* the ventral flap does not form a pendulous dewlap and extends very little beyond the ventral spine, even in the adult; the surface of the flap is rough, with modified scales, and no finlike rays are visible except upon dissection. The caudal peduncle is usually smooth or it may have bristly spines. Most of the monacanthids belong to this genus, which differs from nearly related genera principally in the size and structure of the ventral flap. The species are all small.

Key to the Philippine species of Stephanolepis.

a^1. Caudal peduncle with bristly spines on each side............ **S. tomentosus.**
a^2. Caudal peduncle without bristles or spines.
 b^1. Dorsal with twenty-six rays; a large dark spot below anterior half of soft dorsal; profile of snout straight.......................... **S. cryptodon.**
 b^2. Dorsal with thirty rays; gill slit in a velvety blackish spot; snout concave .... **S. melanocephalus.**

Stephanolepis tomentosus (Linnæus). Plate 1, fig. 4.

Balistes tomentosus LINNÆUS, Syst. Nat. ed. 10 1 (1758) 328.
Monacanthus tomentosus BLEEKER, Atlas Ichth. 5 (1865) pl. 220, fig. 1, masc., pl. 229, fig. 1, female; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272.
Monacanthus nemurus JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 36.

Local name: *Bitig*, Tao Sug.

Dorsal I, 26–29; anal 25–28. Measured from origin of soft dorsal to anal, depth contained from 1.65 to twice in length, in most of my specimens about 1.9 times; the pointed head contained from 3.15 to 3.3 times in length; the concave snout contained from 1.3 to 1.45 times in head; the large circular eyes high up, a diameter below the convex interorbital space, and contained from 2.6 to 3.25 times in head and from 1.8 to 2.37 in snout; the nearly vertical gill slit lies between upper anterior corner of pectoral and posterior half of eye, its upper end sometimes extending a trifle behind a vertical from rear margin of eye; the stout, backward-curved dorsal spine placed over posterior half of eye and usually a little shorter than head, though occasionally a trifle longer; on angles of posterior side of spine are two rows of less than ten each of strong, downward-curved, hooked barbs; anterior surface may be smooth or more or less roughened, or with a few feebly developed barbs; ventral spine free, movable, and armed with stout, strongly recurved barbs on each side; soft dorsal and anal rather low, their middle rays

highest; posterior margin of the large caudal fin convex, its length nearly or quite a fourth of that of head and trunk together; body everywhere covered with very small scales, each bearing from three to five tiny rigid sharp spines on posterior margin, the central one usually the longest; when stroked toward the tail the skin feels more or less velvety, but if stroked in the opposite direction it is very harsh, like the coarsest sandpaper; on each side of caudal peduncle is an oblong or elongated patch of bristly spines of greater or lesser length; they may be very conspicuous in males but small or absent in females or young.

Color in alcohol varies from brownish gray to dark brown, more or less mottled with streaks and blotches of darker or blackish brown; a broad irregular whitish band, with a dark blotch above and below it, is usually present on sides, extending from behind gill opening to a point above anus; caudal fin has two broad dark crossbands; the other fins are colorless.

The above description is based upon an examination of twenty-one specimens, varying in length from 35 to 85 millimeters, obtained in the following localities: Puerto Galera and Calapan, Mindoro; Bantayan Island; Dicuayan Island, Busuanga; Cuyo Island; Puerto Princesa, Palawan; Dumaguete, Oriental Negros; Zamboanga and Caldera Bay, Mindanao; Samal Island, Davao, Mindanao; Jolo; Balabac. The largest specimen, one from Puerto Princesa, Palawan, has a length over all of 105 millimeters.

A specimen from Samal Island was bluish grass green when fresh, darker above and paler below; the snout was thickly sprinkled with black dots, which also occurred behind eyes and along sides; a broad band of soft white passed backward from behind gill slit to a point beneath origin of soft dorsal, where it curved upward above level of top of caudal peduncle; a narrow blotch of weak black above anterior half and a more rounded one under the middle of the white band; a short longitudinal bar of white behind eye; three small bands of very pale evanescent sepia on the yellowish throat and breast; the spinous dorsal dark, with pale brown membrane; the rays of the soft dorsal and anal were reddish, the membranes colorless; the rays of caudal bright grass green, the membranes brownish, with a black spot on the two upper and the two lower membranes; a narrow marginal dark band followed by a narrow white one similar to the lateral band and then another narrow dark band; all three evanescent and incomplete or not well defined.

In the Bureau of Science collection is a specimen without label (unquestionably from the Philippines and probably from Calapan, Mindoro), which has the body covered with exceedingly small scales with here and there pale threadlike fibrils scattered over head and body; the filaments are most numerous on ventral half of body, the longest ones about the diameter of an eye in length; no patch of spiny fibrils on caudal peduncle. Aside from the greater fineness of the scales and the presence of the fibrils on the body, the specimen is typical of *M. tomentosus*.

I also refer here twenty-six young specimens collected by E. H. Taylor on the southern coast of Cotabato Province, Mindanao; they are all small, from 35 to 44 millimeters in length, and lack the bristly spines on the caudal peduncle and also the whitish band on the side.

This insignificant species is found about coral reefs throughout the central and southern Philippines and has been reported by Jordan and Seale from Manila and Panay Island; by Jordan and Richardson from Lubang Island and from Cuyo; and by Vaillant from Palawan. At Cuyo it is called *pagnesan* and by the people of Samal Island it is known as *peleg*.

A common East Indian fish, said to range from Singapore to the northern coast of Australia, and northward to the coast of China.

Stephanolepis cryptodon (Bleeker).

Monacanthus cryptodon BLEEKER, Nat. Tijdschr. Ned. Ind. 8 (1855) 431; GÜNTHER, Cat. Fishes 8 (1870) 233.

Paramonacanthus cryptodon BLEEKER, Atlas Ichth. 5 (1865) 131, pl. 225, fig. 1.

Dorsal I, 26; anal 26. Depth at origin of soft dorsal contained 2.25 in length, and head 3.3 times; profile forms a straight line from dorsal spine to top of snout, which is 0.25 of the length and is contained 1.2 times in head; the circular eyes high up, a half diameter below profile, and contained $2\frac{1}{8}$ times in snout and 2.8 times in head; the slightly oblique gill slit a little shorter than eye and lies wholly beneath posterior half of eye; the slightly curved, sharp-pointed, and rather slender dorsal spine is over posterior half of eye and contained 1.3 times in head; on either side of posterior part of spine is a row of six or eight feebly developed downward-pointing prickles; ventral spine small, slender, movable, and armed with a few very small, straight spinelets; soft dorsal highest anteriorly, the

longest rays a little greater than an eye diameter; anal similar in outline, but lower; length of caudal fin 0.25 of that of head and body together, its posterior margin convex; head and body covered everywhere with minute scales, which feel like fine sandpaper; no spines or bristles on caudal peduncle.

Color in alcohol of a badly faded specimen brown, throat and belly pale, with a large blackish brown spot on each side below anterior half of soft dorsal; there are traces of dark bands on throat and of dark brown blotches and marblings on head and body; there are also indications of small dark spots sprinkled over body; there is a dark spot behind soft dorsal and anal fins, on caudal peduncle; dorsal spine brown barred, with a whitish tip, its membrane very pale brown; caudal brown, with two dark crossbands; the other fins are all pale.

I have referred here a small, poorly preserved specimen, 56 millimeters long, collected at Balayan Bay, Batangas, in 1908. It differs from typical *Monacanthus cryptodon* in having two rows of poorly developed barbs on the dorsal spine, instead of being merely rough.

This species has been known hitherto only from Bleeker's collections in Celebes and Amboina. It is close to *Monacanthus choirocephalus* and *M. nemurus*, but differs in the smaller number of dorsal and anal rays, the shape of the profile, the position of the eye, and the coloration.

Stephanolepis melanocephalus (Bleeker).

Monacanthus melanocephalus BLEEKER, Nat. Tijdschr. Ned. Ind. 5 (1853) 95, Atlas Ichth. 5 (1865) 127, pl. 223, fig. 1; GÜNTHER, Cat. Fishes 8 (1870) 242.

Balistes monoceros LACÉPÈDE, Hist. Nat. Poiss. 1 (1798) pl. 17, fig. 3 (the description only in part).

Monacanthus janthinosoma BLEEKER, Nat. Tijdschr. Ned. Ind. 6 (1854) 504.

Dorsal I, 30; anal 27. Depth of body, measured from origin of soft dorsal to anal, contained nearly 2.2 times in length, while the extreme depth across ventral flap is 1.7 times in length or twice in the total, including caudal fin; the pointed head is 3.18 times in length and the strongly concave snout 1.3 times in head; the moderately large and circular eye placed high up, very close to dorsal spine, its diameter contained 3.14 times in snout; gill slit extends diagonally upward and backward from in front of upper end of base of pectoral, but lies wholly under eye, its length $\frac{5}{7}$ of diameter of eye; the long, stout, erect dorsal spine is directly over center of eye, its length nearly equal

to that of head, and has about twelve downward-pointing stout spines on each side; back smooth, front rough, with two rows of small, closely set, upward-pointing spines on upper portion; soft dorsal and anal much the highest anteriorly, the rays there nearly twice as long as the posterior ones; caudal peduncle noticeably wide and short; ventral flap of moderate width, surface diagonally ridged and rough, ventral spine well developed, free, and movable, armed with strong sharp-pointed spines; the broad caudal fin 0.2 as long as head and body together; body covered with small to minute scales; those on chin and belly blunt and rounded, the rest each with a single hard sharp spine, longer and better developed on the scales of posterior part of caudal peduncle.

Color in alcohol brown, very dark above, paler ventrally, with a velvety blackish brown spot around gill opening; ventral flap with a dark brown band marginally; rays of caudal fin dark brown basally, becoming lighter toward their tips; several alternate blackish and pale lines at the free end; soft dorsal, anal, and pectoral fins all pale.

Here described from a specimen 70 millimeters long, collected in January, 1921, at Calapan, Mindoro. This distinct and easily recognized species, not heretofore recorded from the Philippines, is known only from the Dutch East Indies.

Genus CANTHERINES Swainson

Cantherines SWAINSON, Nat. Hist. Fishes 2 (1839) 327.

This genus much resembles *Monacanthus*, the chief difference being that the ventral spine is fastened immovably to the pelvic bone. The dorsal varies; in some species it is merely roughened and in others it has four rows of more or less well-developed barbs, there being every gradation between.

Key to the Philippine species of Cantherines.

a^1. Scales relatively coarse; scattered cutaneous filaments on sides of body .... **C. macrurus.**

a^2. Scales finer than in *macrurus;* body without cutaneous filaments.

- b^1. No spines on caudal peduncle.
  - c^1. Scales minute, those before caudal fin bristly or hairy; snout as long as head; eyes 3.5 to 3.75 in head; color dark with a faint paler network.......... **C. pardalis.**
  - c^2. Scales not distinct; snout 1.25 in head; eyes 2.3 in head; color brown with squarish darker spots in regular longitudinal and transverse rows.......... **C. tessellatus.**
- b^2. Caudal peduncle usually with four spines in two rows of two each; color very dark without network or regularly arranged spots. **C. sandwichiensis.**

Cantherines macrurus (Bleeker). Plate 2, fig. 1.

Monacanthus macrurus BLEEKER, Nat. Tijdschr. Ned. Ind. **12** (1856–57) 226; GÜNTHER, Cat. Fishes **8** (1870) 247.

Pseudomonacanthus macrurus BLEEKER, Atlas Ichth. **5** (1865) 134, pl. 228, fig. 2.

Cantherines macrurus JORDAN and SEALE, Proc. U. S. Nat. Mus. **28** (1905) 790; EVERMANN and SEALE, Bull. Bur. Fisheries **26** (1906) 100.

Local name: *Bungaong*, Sulu moro.

Dorsal I, 29–30; anal 27–29. The depth of the elongate and strongly compressed body is from twice to more than 2.25 times in length; head not greatly produced and contained from 3.3 to 4.3 times in length; the concave snout a little longer than head, or in young specimens of the same length, 3.75 to 4 times in length; the large eyes placed very far back and high up and contained about 2.5 times in head; gill openings are smaller than eyes and extend farther forward than anterior margin of eye, except in very young specimens, when they lie wholly beneath the eye; the spinous dorsal is over posterior half of eye, its length $1\frac{1}{6}$ to $1\frac{1}{3}$ times in head; two rows of strong hooked barbs on posterior side; those on front of spine much smaller and so close together as to appear like one row; ventral spine small, rough, and immovable; body covered everywhere with distinctly visible spinescent scales, much coarser than in the other species of *Cantherines*, with very few to many threadlike or stringy filaments scattered over sides of body; caudal fin longer than head or snout, its free end rounded; dorsal and anal fins low; on lower half of caudal peduncle are two or three sharp-pointed spines with tips recurved forward; these spines are difficult to see in some specimens and in the very young are altogether absent, but with age they become large, strong, and very plainly evident.

In alcohol the color varies from brownish gray to olive brown, with many small circular dark brown dots scattered over entire surface; on chin and breast are three or four dark transverse bands and over sides and back are diagonal irregular dusky bands and blotches; the rays of caudal fin are dark with dark transverse bands; the soft dorsal, anal, and pectorals are all pale.

I have examined six specimens of this little fish from the following localities: Bacon, Sorsogon, length 112 millimeters; Calapan, Mindoro, 119 millimeters; Bantayan Island, 127 milli-

meters; Balabac, 62 millimeters; Dicuayan Island, Busuanga, 45 and 43 millimeters.

The Balabac specimen was painted from life by T. S. Espinosa, in 1908, and had the following colors: The whole body was olive brown with a patch of yellow on the chin and darker olive on the top of the head, back, and along the caudal peduncle; the whole body with circular, very dark olive spots thinly scattered over it; the soft dorsal and anal rays were bright orange, the membranes colorless; pectoral nearly colorless, with a slight tinge of yellow basally; the basal half of the caudal rays olive green, their outer half olive brown; the membranes dark olive brown with a broad dark band posteriorly and a narrow one across the middle of the basal half; the tip of the ventral flap dark with half transparent greenish white spines.

Cantherines pardalis (Rüppell).

Monacanthus pardalis RÜPPELL, Neue Wirbelt., Fische (1835) 57, pl. 15, fig. 3; GÜNTHER, Fische der Südsee **3** (1910) 498, pl. 169, fig. B; Report Shore Fishes, Zool. Voy. Challenger **1** [6] (1880) 54.

Liomonacanthus pardalis BLEEKER, Atlas Ichth. **5** (1865) 136, pl. 230, fig. 2.

Dorsal I, 34–36; anal 30–31. Body strongly compressed laterally and much extended ventrally, depth contained from 1.8 to 1.85 times in length; the pointed head contained from 3.6 to 3.68 times in length; the circular eyes rather large, their diameter contained from 3.5 to 3.75 times in head, and placed high up and very far back, so that the elongated, slightly concave snout is as long as head; interorbital space very convex; lips broad but rather thin, mouth small, and the irregular, pointed white teeth have more or less brownish tips; gill slit slightly oblique, its length less than 0.25 greater than an eye diameter; first dorsal spine above the forward half of eye, long, rather slender, without barbs but moderately roughened, its length equal to or 1.2 times in head; a rudimentary spine concealed behind dorsal spine; dorsal groove deep anteriorly, but shallow posteriorly; soft dorsal and anal similar in outline, both a little elevated anteriorly; posterior margin of caudal convex; pelvic spine not movable; skin everywhere covered with very small, minutely spinescent scales which are velvety when stroked toward tail, but like fine sandpaper when rubbed in the opposite direction; on sides of caudal peduncle a little before fin the scales have longer spiny processes, so that the region seems to

be covered with minute hairs or bristles; no spines on caudal peduncle.

This species possesses to a remarkable degree the power to change its color to conform with its environment. A living specimen in the Bureau of Science Aquarium, taken at Calapan, Mindoro, is a very dark brown, with a faint polygonal or hexagonal pale network over body; on sides of head are very faint wavy lines which converge toward mouth; soft dorsal and anal rays are pale reddish orange and caudal brownish yellow; pectoral colorless, with a very dark brown or black base.

When bothered for some time the fish crept under the overhanging margin of a valve of a small *Tridacna* and immediately changed its color to match the greenish cement behind it; no other color was present except a broad black bar between and including the eyes, and a black bar at the base of each pectoral. Upon being further disturbed, the fish after a while came to rest in a side angle of the tank and this time was a peculiar gray or slate color, with irregular vertical crossbands of dirty white, which were more evident on the ventral portion than on the sides; around the mouth and head the bands formed rings, completely encircling them; two white bands on the caudal peduncle were also very distinct; both eyes and the interorbital space were covered by a broad black band; there was a short black bar at the base of the pectoral and a black stripe along the base of the second dorsal; the fins were all very pale except the caudal, which was barred like the body, but was mostly slate color. When the fish was forced to leave, the white faded out, especially toward the caudal which became nearly all slate, and then the original color was resumed. In each instance the color changes were made with very great rapidity, especially when returning to the normal color.

In alcohol the color is uniform dull brownish gray with the polygonal pale network on body showing faintly and the interspaces evident as dark spots; the wavy lines on head are more or less distinct; the membrane of first dorsal and caudal rays is dark brown or colored like body; the remaining fins are all pale.

I have examined two alcoholic specimens, from Zamboanga, Mindanao, and Calapan, Mindoro, having lengths of 125 and 130 millimeters, respectively. The latter, collected in January, 1921, is a female containing eggs. The only previous Philippine record is that of the Challenger Expedition, a single specimen having been obtained from reefs at "Zebu," or Cebu.

Since the above was written E. H. Taylor has collected two specimens, 57 and 77 millimeters long, on the southern coast of Cotabato Province, Mindanao.

It is very interesting to observe living specimens. The long dorsal spine is repeatedly folded and unfolded, being now invisible in its groove and again held rigidly erect; sometimes while erect it is vibrated very rapidly through a small arc. Most of the time locomotion is accomplished solely by means of the rapid undulations of the long soft dorsal and anal, the caudal being held motionless.

Originally described from the Red Sea, this species is known also from Zanzibar, and eastward to the Society Islands.

Cantherines tessellatus (Günther).

Monacanthus tessellatus GÜNTHER, Report Shore Fishes, Zool. Voy. Challenger 1 [6] (1880) 54, pl. 23, fig. B.

Cantherines tessellatus JORDAN and RICHARDSON, Check List of Philippine Fishes (1910) 44.

D. 36, A. 32. Skin velvety, without distinct scales. The depth of the body is one half of the total length (without caudal). Snout long, the distance of the eye from its extremity being two-sevenths of the total length (without caudal). Upper profile very slightly concave. Gill opening below the middle of the eye; root of the pectoral below its posterior half. Dorsal spine rather long, nearly half as high as the body, above the posterior half of the eye, armed with four rows of barbs, of which the anterior are close together. Caudal with the margin rounded. Dorsal and anal fins but little higher anteriorly than posteriorly. Ventral spine small, fixed. Color light brownish. Head and body ornamented with squarish dark brown spots, regularly arranged in transverse and longitudinal series; caudal blackish. Philippine Islands. Length of specimen, 5 inches. Station 204; 115 fathoms.—*Günther.*

In Günther's figure, the snout is contained 1.25 times in head, eyes 2.3 times in head and 1.85 times in snout, and first dorsal spine 1.35 times in head.

Only one specimen is thus far known. Station 204 B, where the *Challenger* caught it by trawling, is off the eastern coast of Banton, an island in the Sibuyan Sea.

Cantherines sandwichiensis (Quoy and Gaimard). Plate 2, fig. 2.

Balistes sandwichiensis QUOY and GAIMARD, Voy Uranie, Zool. (1824) 124.

Cantherines sandwichiensis FOWLER, Proc. Acad. Nat. Sci. Phila. (1900) 514; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 (1903) (1905) 418, fig. 183; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272.

Cantherines carolae JORDAN and MCGREGOR, in Jordan and Evermann, Bull. 47, U. S. Nat. Mus. 2 (1898) 1713; JORDAN and MCGREGOR, Report U. S. Fish Comm. 24 (1898) (1899) 281, pl. 6.

Monacanthus carolae GÜNTHER, Fische der Südsee 3 (1910) 449.

Monacanthus (*Cantherines*) *sandwichiensis* WEBER, Fische der Siboga Exp. (1913) 579.

Dorsal I, 35; anal 31. The oblong, moderately elevated body much compressed laterally, its depth 1.75 times in length; head rather long and pointed and contained 3.5 times in length or about twice in depth; snout a little shorter than head, being 0.93 of length of latter; anterior profile slightly concave, except over eye, where it is convex; from dorsal spine to caudal peduncle the dorsal outline is a long low curve; anal outline exactly similar; from just behind chin the outline is slightly convex to ventral spine; from this point to anal is a straight line; mouth small, lips thin, with the teeth of lower jaw fitting inside upper in closed mouth; tips of the dingy whitish teeth brownish; eyes high up with a strongly convex interorbital space; gill slit directly beneath eye and slightly oblique, its lower or anterior end in front of upper part of base of pectoral, its length greater than diameter of eye.

Surface of body everywhere like sandpaper when stroked toward head, or like very fine sandpaper when rubbed toward tail; dorsal spine inserted slightly in advance of middle of eye, moderately stout, and rougher than body, its length $\frac{5}{6}$ of head; anterior rays of soft dorsal and anal more elongated than posterior ones; posterior end of caudal fin convex; pelvic spine very short, rough, stiff, and immovable; no spines on caudal peduncle in my specimen; it is stated that males have two rows, each of two short recurved spines, on each side of caudal peduncle.

In alcohol the entire animal is uniform dull brownish plum color; the dorsal spine is dusky, with dark brown membrane; the pectorals, soft dorsal, and anal are very pale, slightly tinged with yellowish.

Here described from a specimen collected in Balabac in 1908, by Alvin Seale. This specimen was drawn in color from life by T. S. Espinosa. The whole body was uniform purplish black; the rays of the soft dorsal and anal were orange, the membranes colorless; the caudal rays were very dark blackish brown, the membranes light yellowish brown; the dorsal spine was the same color as the body, its membrane umber; the pectoral was pale greenish yellow; teeth whitish.

Jordan and Richardson listed three small specimens from Romblon Island, and Max Weber collected one at Sanguisiapo, an islet off the southwest coast of Tawitawi.

This species is abundant at Hawaii, and in the Revillagigedo Archipelago, off the coast of Mexico, where *C. pardalis* seems to be lacking. It is evidently not common in the Philippines or the East Indies, though it is said to occur in the Indian Ocean as far to the west as Mauritius.

Genus **OXYMONACANTHUS** Bleeker

Oxymonacanthus BLEEKER, Atlas Ichth. 5 (1865) 100 and 137; Ned. Tijdschr. Dierk. 3 (1866) 13, not p. 16 as in Jordan's Genera 3 (1919) 340.

Body oblong, the back not angular. Length of head greater than its depth, snout exceedingly long, narrow, and sharp pointed, the end tubular and the small mouth not terminal but opening upward; dorsal spine inserted over middle of eye, and lightly armed with spinelets; ventral spine immovable; caudal peduncle compressed, the narrowest part much higher than wide; skin slightly rough, with a patch of small bristles on caudal peduncle in males.

Only a single species is known, confined to the tropical waters of the Indian and Pacific Oceans.

Oxymonacanthus longirostris (Bloch and Schneider). Plate 2, fig. 3.

Balistes hispidus var. *longirostris* BLOCH and SCHNEIDER, Syst. Ichth. (1801) 464.

Monacanthus longirostris CUVIER, Regne Anim. ed. 1, 2 (1829) 152; GÜNTHER, Cat. Fishes 8 (1870) 233; Fische der Südsee 3 (1910) 450.

Monacanthus chrysospilos BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 126.

Oxymonacanthus chrysospilus BLEEKER, Ned. Tijdschr. Dierk. 2 (1865) 143.

Oxymonacanthus longirostris BLEEKER, Atlas Ichth. 5 (1865) 137, pl. 224, fig. 1; JORDAN and SEALE, Bull. Bur. Fisheries 25 (1905) 365, pl. 50, fig. 2.

Dorsal I, 31 to 33; anal 29 to 31.

Scales minute, rough, the spinules being a little longer on the sides of the tail. Body oblong, its depth being one-third of the total length (without caudal). Snout much produced and pointed, the upper and lower profiles being nearly equally oblique. Dorsal spine rather strong, straight,

rough, rather shorter than the snout, inserted above the middle of the eye. Caudal fin rounded, short. Ventral spine not moveable, attached to the abdomen by a single membrane; dorsal and anal fins low. Bluish or greenish, with more or less regular series of rounded reddish, dark-edged spots, which are larger than the spaces of the ground color between them. Sometimes a vertical black spot on the posterior half of the caudal fin; sometimes small, white, brown-edged ocelli above the ventral spine.—*Günther*.

A specimen of this unique and brilliantly colored little fish was obtained by Seale at Samal Island, in Davao Gulf, in 1908; but it seems to have been either lost or misplaced, as I have been unable to locate it in the Bureau of Science collection. A colored drawing by T. S. Espinosa shows it to have been 42 millimeters long, or 52 millimeters long over all. The body was blue, darkest on the upper part of the head and very pale blue on the caudal peduncle, with about six longitudinal rows of elongated orange spots on the body and similar stripes on the head converging toward the pointed, white-tipped snout; the soft dorsal and anal fins were nearly colorless, each with a narrow yellow band along the base; the first dorsal spine was a trifle darker, with a very pale brown membrane; the ventral spine was brown; the rays of the caudal were bluish white, the membrane yellowish white, with a large black blotch on the lower half of the posterior portion of the fin.

This fish, different in shape and in its gaudy colors from all other filefishes, has not hitherto been recorded from the Philippines. It occurs from Mauritius eastward to Guam and the islands of the South Pacific.

Genus **ALUTERA** (Cuvier) Oken

Les Alutères CUVIER, Regne Anim. ed. 1, 2 (1817) 153.
Alutera OKEN, Isis (1817) 1182.

The large, elongate, thin, and strongly compressed body is covered with minute scales; head obtuse, snout short and convex; mouth and teeth much like those of *Monacanthus*, but the lower jaw a little projecting; gill opening an oblique slit, longer than eye, and below and forward of eye, its posterior end behind base of pectorals; pelvic bone long, sickle-shaped, movable under the skin, and without spine at its tip; the small, rough, barbless dorsal spine inserted above eye; soft dorsal and anal long, each with from forty-five to fifty rays; caudal peduncle narrow, its width 3 to 4 times in snout; caudal fin shorter than head, its pos-

terior extremity nearly truncate, the middle rays but little elongated.

The coloration is uniform brown, mottled with darker brown. There is perhaps but a single species of very wide distribution, occurring in all tropical and subtropical seas.

Alutera monoceros (Osbeck).

Balistes monoceros OSBECK, Iter Chinensis (1757) 110.

Alutera monoceros JORDAN and EVERMANN, U. S. Nat. Mus. Bull. 47, **2** (1898) 1720; JORDAN and FOWLER, Proc. U. S. Nat. Mus. **25** (1902) 274; JORDAN and EVERMANN, Bull. U. S. Fish Comm. **23**[1] (1903) (1905) 423, fig. 185; JORDAN and SEALE, Bull. Bur. Fisheries **26** (1906) 36.

Aluteres berardi LESSON, Voy. Coquille, Zool. 1st part, **2** (1830) 108, pl. 7.

Alutera cinerea SCHLEGEL, Fauna Japonica **3** (1842) 292, pl. 131, fig. 1.

Aleuteres berardi RICHARDSON, Zool. Voy. Sulphur, Ichth. **132** (1845) pl. 61, fig. 1.

Aluteres monoceros BLEEKER, Atlas Ichth. **5** (1865) 140, pl. 226, fig. 2.

Monacanthus monoceros GÜNTHER, Cat. Fishes **8** (1870) 251; DAY, Fishes of India (1878) 693, pl. 179, fig. 2.

Dorsal I, 50; anal 52 in my specimen, but the rays in the soft dorsal vary from forty-five to fifty and in the anal from forty-eight to fifty-three. The oblong body strongly compressed, its depth about 2.5 times in length; head very deep, with upper and lower profiles each convex; head, measured to the lower or anterior end of gill slit 3.9 times in length, to the upper end 3.1 in length, and to base of pectoral 3.5 times in length, the last equal to the thin, narrow snout; mouth small, subterminal, chin slightly projecting; the circular eye contained 4.4 times in snout, and placed far back and high up, the distance from its upper margin to dorsal spine equal to its own diameter; gill slit half again as long as eye; its upper or posterior end beneath posterior margin of eye, between the latter and pectoral fin; the lower or anterior end of gill slit lies in front of upper part of pectoral base and forward of eye; dorsal spine rough, with four rows of very small barbs, and inserted a trifle anterior to middle of eye; it is very weak and slender and in my specimen has been broken off, leaving but a stub; soft dorsal and anal fins low, alike in shape, highest anteriorly; caudal fin convex, its length 5.75 times in head and body; skin covered with minute scales bearing excessively small spinelets, and velvety to the touch when rubbed

toward tail, but like the finest emery cloth when stroked in the opposite direction.

Color in alcohol pale brown above, the ventral half of head and trunk whitish, mottled with darker brown; tail dusky, the other fins all colorless.

This description is from a specimen having a total length of 190 millimeters, or 157 millimeters without the tail, obtained by Seale in the Manila market in 1907. The only other Philippine record is that of Jordan and Seale, who had a small specimen, also from Manila.

This circumtropical fish occurs in all warm seas, north to China and Japan in the Pacific, and to Cape Cod, Massachusetts, in the Atlantic, but is most abundant in the East and West Indies. It seems to vary greatly with age, and has accordingly been described under many names, of which I have quoted only a few. It attains a length of 610 millimeters and, according to Osbeck and Siebold, is eaten in China and Japan. Day quotes Osbeck as saying "looks like a flounder at a distance and has almost the same taste, but is not so fat."

In Manila it is said by the Tagalogs to be poisonous.

Genus **OSBECKIA** Jordan and Evermann

Osbeckia JORDAN and EVERMANN, Check List of Fishes, Report U. S. Fish Comm. (1895) (1896) 424.

This genus is very close to *Alutera* but differs particularly in the very long caudal fin, with much elongated middle rays and short marginal ones; head pointed, with a long snout and concave upper profile; caudal peduncle wide, twice in snout; coloration bizarre, not uniform, with irregular blue spots and lines and circular black polka dots.

There is but a single circumtropical species, which occurs in all warm seas.

Osbeckia scripta (Osbeck).

Balistes scriptus OSBECK, Iter Chinensis 1 (1757) 144.
Balistes laevis BLOCH, Ichthyol. 12 (1797) 65, pl. 414.
Osbeckia scripta JENKINS, Bull. U. S. Fish Comm. 22 (1902) 484; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23[1] (1903) (1905) 422, fig. 184; JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 276; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906).
Aleuteres laevis RICHARDSON, Zool. Voy. Sulphur, Ichth. (1845) 31, pl. 61, fig. 3.

Aluteres scriptus BLEEKER, Atlas Ichth. 5 (1865) 141, pl. 227, fig. 4.
Monacanthus scriptus GÜNTHER, Cat. Fishes 8 (1870) 252; DAY, Fishes of India (1878) 694, pl. 176, fig. 3 (plate numbered incorrectly in text and labeled *Anacanthus*).
Alutera scripta JORDAN and EVERMANN, Fishes N. and M. America, U. S. Nat. Mus. Bull. 47 (1898) 1719.

Local name: *Samarang,* Tao Sug. Filefish, foolfish, unicorn fish, English.

Dorsal I, 45–48; anal 50–51. The depth of the oblong and greatly compressed body is contained from 2.8 to more than 3.1 times in head and trunk and is nearly or quite equal to the elongated caudal fin; mouth small, oblique, with broad, fleshy lips, prominent teeth, and heavy, rounded chin jutting out beyond it; the narrow, elongated, concave snout equals length of head to base of pectoral and is contained from 3.4 to 3.75 times in length; distance from tip of snout to gill opening contained from 3.75 to 4 times in length; eye large, circular, its diameter contained from 4.3 to 5.1 times in snout, far back and very high up, the convex interorbital space wider than an eye diameter; base of pectoral below middle or anterior half of eye; upper or posterior end of the long, diagonal gill slit lies below posterior half of eye, its middle below anterior margin of eye, and the lower end in front of middle of pectoral; the unarmed dorsal spine is over middle or posterior half of eye and varies greatly in length; in one specimen it is a stubby, sharp-pointed prickle, less than half an eye diameter in length; in my largest specimen, it is 7 times as long, slender and weak, half as long as snout, while in another, rather small specimen it is 0.64 as long as snout; soft dorsal and anal fins moderately low, of similar outline, and nearly uniform in height throughout their length, the anal fin the longer; caudal fin wide and long, the median rays the longest, from 2.5 to 3.2 times in length, its width about $\frac{5}{8}$ of its length; skin covered with minute scales and almost velvety to the touch.

The color of alcoholic specimens may be chocolate brown, buff, light brown, or gray brown, with irregular blue or darker brown streaks and lines, everywhere sprinkled with rather large blackish or dark dots, the arrangement of the lines about the dots often resembling oriental or cabalistic script; caudal fin dark, with darker crossbands; the other fins colorless.

Here described from eight specimens varying in length from 82 to 260 millimeters, obtained at the following localities: Iba, Zambales; Manila; Calapan, Mindoro; San Miguel Bay, Cama-

rines; Jolo, Sulu. It has been listed previously from Jolo, by Evermann and Seale.

This circumtropical fish occurs in all warm seas, northward to Japan, Hawaii, the west coast of Mexico, and South Carolina, southward in the Pacific Ocean throughout Polynesia, in the Indian Ocean to Zanzibar, and in the Atlantic Ocean to Brazil and the Canary Islands. It reaches a length of nearly a meter but, like its congeners, is not only worthless but dangerous, as its flesh is poisonous.

Genus **PSEUDALUTERES** Bleeker

Pseudaluteres BLEEKER, Atlas Ichth. 5 (1865) 100 and 139; Ned. Tijdschr. Dierk. 3 (1866) 14.
Pseudaluterias BLEEKER, Ned. Tijdschr. Dierk. 2 (1865) 273.

This genus is especially distinguished by the position of the first dorsal, the weak slender spine being placed on the snout forward of the eye; body oblong, with belly not at all prominent; snout convex and gill openings behind eyes; in males there is a small patch of bristles on the sides of the caudal peduncle. The second spine of the first dorsal is reduced to a short blunt rudiment and the ventral is entirely wanting.

But a single small species is known of this genus, which is closely related to *Osbeckia*.

Pseudaluteres nasicornis (Schlegel).

Alutera nasicornis SCHLEGEL, Fauna Japonica, Poiss. (1846) 223, 131, fig. 2.
Pseudaluteres nasicornis BLEEKER, Atlas Ichth. 5 (1865) 139, pl. 221, fig. 1, male; pl. 224, fig. 2, female.

Dorsal II, 46–49; anal 43–46. Depth contained from 3.3 to 3.4 times, and head about 3.75 times in length; snout contained from 1.4 to 1.7 times in head; eye contained about 4 times in head and from 2 to 2.6 times in snout; the length of the slender, barbless dorsal spine may be a little greater or less than that of head and it is placed far forward of eyes; distance from spine to tip of snout contained from 2 to 2.6 times in head; snout convex, mouth small, and lower jaw projects slightly; length of gill opening smaller than diameter of eye and well behind posterior margin of eye; the free margin of caudal but little convex, the angles not rounded; second dorsal begins in advance of anal; both are low, long, and of similar outline; body entirely and uni-

formly covered with minute scales which feel velvety when stroked toward tail but like fine sandpaper when rubbed in the reverse direction.

Color in alcohol uniform pale yellowish brown, paler beneath; a dark brown stripe on each side of back, beginning at dorsal spine and extending to posterior extremity of soft dorsal; a similar stripe extends from eye to base of caudal fin; middle of caudal fin very dark brown.

Here described from three specimens having lengths of 56, 64, and 75 millimeters. The first two were collected by Alvin Seale, in 1907, and the last by students of Silliman Institute, in 1913, at Dumaguete, Oriental Negros.

Since writing the above I have received two specimens, 40 and 42 millimeters in length, from E. H. Taylor, who collected them on the southern coast of Cotabato Province, Mindanao. They are brownish along the back, merging into white on the belly, with a bright silvery luster over all; the caudal fin is black, with pale margins.

This unimportant little fish is known from Zanzibar and Mauritius to Japan.

PSILOCEPHALIDÆ

The fishes of this family have the body narrow, meager, much elongated, with strangely formed elongate head, the mouth above, and a long wide fleshy barbel on the chin; the gill openings are forward of the eyes; the first dorsal fin is reduced to a very small feeble spine placed over the hind margin of the eye; vertebræ twenty-nine or thirty.

A peculiar family containing one genus with but a single remarkable species.

Genus **PSILOCEPHALUS** Swainson

Psilocephalus SWAINSON, Nat. Hist., Fishes 2 (1839) 327.

Dorsal I, 44–52; anal 57–65. The generic characters are as above; the soft dorsal and anal are long, with many rays; the conspicuous lateral line begins behind mouth and passes backward and upward toward eye, around which it curves downward and then upward to a point opposite upper part of eye; thence it runs posteriorly parallel with back to a point about over anus, from which it descends and proceeds along the middle line of body to tail.

Psilocephalus barbatus (Gray).

Balistes barbatus GRAY, Illustr. Indian Zool. 1 (1830) Pisces, pl. 1, fig. 2.

Psilocephalus barbatus SWAINSON, Nat. Hist., Fishes 2 (1839) 327; BLEEKER, Atlas Ichth. 5 (1865) 143, pl. 226, fig. 1 (male).

Anacanthus barbatus GRAY, Zool. Misc. (1831) 8 (name preoccupied); GÜNTHER, Cat. Fishes 8 (1870) 255; DAY, Fishes of India (1878) 694, pl. 179, fig. 1 (female).

Aluterus barbatus HOLLARD, Ann. Sci. Nat. II 4 (1855) 17, pl. 1, fig. 4 (very poor figure).

Dorsal I, 49; anal 57. This extraordinary-looking fish is recognized at first glance, as it is entirely unlike any other plectognath fish. The elongated head, trunk, and tail, the peculiar mouth and protruding chin (the latter with a long barbel), and the strange position of the gill slit, all serve to emphasize its difference. The depth is contained $7\frac{2}{3}$ times in length and 11.1 in the length over all; distance from tip of snout to gill slit contained 4.6 times in length, from tip of snout to base of pectoral 3.45 times in length, from tip of snout to end of skull 3.23 times in length, while the distance from point of chin to base of skull is 2.95 times in length; head excessively elongated, its depth at base of pectoral being but $\frac{1}{8}$ of its length; the long, thin snout is a straight line to base of upper lip where it is sharply upturned, and is contained 1.28 times in head; lips thick and the small mouth is made strongly oblique or vertical by the boldly protruding chin and upturned lower jaw; from the chin hangs a long barbel, very stout at base but threadlike toward tip, its length a little more than 8 times in head and trunk; the circular eye is far back and high up, not over half its diameter below profile, and is rather small, being contained 6.25 times in snout and 8 times in head; gill slit low, strongly inclined, its upper or posterior end beneath anterior margin of eye (or wholly in advance of eye), its length a trifle less than width of eye in my specimen; base of pectoral behind eye; the slender, short, unarmed, and feeble dorsal spine inserted over posterior margin of eye; the soft dorsal and anal fins both low, anal extending farther forward and backward than does the first named; the length of the long, narrow, wedge-shaped caudal fin is contained 2.37 times in head and trunk, the middle rays more than twice the length of the outer ones; skin smooth to the touch; the scales visible only with the aid of a lens; vertebræ thirty.

The color in alcohol is uniform light brown, the head paler; barbel blackish brown; caudal fin dark, with six or more dark crossbars; the other fins all very pale yellowish.

The above description is written from a female specimen, filled with eggs, taken by L. E. Griffin at Bantayan Island in May, 1909. Its length is 207 millimeters; caudal fin, 87; chin, 6; total length over all, 300 millimeters. Male specimens have a long ventral skinny flap in the form of an elongated obtuse triangle, the base extending from near the chin to the anus.

This singular fish, not heretofore recorded from the Philippines, is abundant on the coast of Hindustan about Madras, and occurs eastward throughout the East Indies at least as far as Celebes.

Suborder OSTRACODERMI

TRUNKFISHES

Local names: *Baca-baca,* Filipino Spanish; *tikung,* Visayan.

This small group contains but a single family and includes those plectognaths in which the body is inclosed in a rigid bony box made up of six-sided plates joined by structures, so that only the jaws, fins, and tail are movable. Spinous dorsal and ventral fins are lacking, while the pectorals, soft dorsal, and anal are all small. The mouth is small, and the bones of the jaws are fused, each jaw having but a single row of long narrow teeth. There are but fourteen vertebræ, the anterior ones elongate, the last five very short; there are no ribs.

The body is short, three-, four-, or five-sided; the gill opening is an almost vertical slit below and behind the eye.

This group, a singular offshoot from the Sclerodermi, represents a development along a line of defense entirely different from that followed by any other plectognaths. The single family is composed of a few kinds of small or medium-sized fishes, usually considered to possess feeble swimming powers. They are widely distributed in all warm seas, where they live near the bottom in shallow water. They are carried great distances by ocean currents, in which they drift almost helplessly. According to Bleeker, very large specimens are quick, powerful swimmers, though probably only for short dashes.

Trunkfishes are often cooked and eaten, the fish being gutted through an incision in the belly and then baked in the shell. They are usually considered to be wholesome, but Dr. Leon M. Guerrero of the Bureau of Science informs me that the flesh of large specimens is poisonous. However, their powerful coat of mail seems to make unnecessary the development of poisonous alkaloids to the same extent as in the hornfishes, trigger fishes,

and puffers. From the time of the first tropical explorers the trunkfishes have been well known, since they are easily dried, and have been in demand in Europe and America as curiosities.

OSTRACIIDÆ

The short body is more or less cubical, and is inclosed in a shell, as previously stated, only the jaws, fin bases, and caudal peduncle being free and covered by smooth skin. One of the two genera is known from the Philippines.

Genus OSTRACION Linnæus

Ostracion LINNÆUS, Syst. Nat. ed. 10 (1758) 330.

In this genus the coat of mail is continuous behind the anal fin, and not open as in *Aracana* Gray, which as yet is not recorded from the Philippines. Spines may be present or absent on the head and abdomen; the middle of the back may be smooth, with a ridge running lengthwise, or this may be crowned by a long sharp spine; ridges are developed at the sides and the trunk may be either four- or five-angled; the dorsal rays are nine or ten, the caudal rays always ten in number.

Key to the Philippine species of Ostracion.

a^1. Shell five-ridged, the dorsal ridge usually topped by a long spine; spine over eye pointing up; spines on ventrolateral ridges pointing backward (subgenus *Tetrosomus*) .... **O. gibbosus.**

a^2. Shell four-angled, dorsal ridge absent or very low, with or without a very small spine.

b^1. No spine over eye (subgenus *Ostracion*).

c^1. No median dorsal ridge; anal behind dorsal; a large ocellus on each plate on top and sides of trunk .... **O. tuberculatus.**

c^2. A low median dorsal ridge; anal origin under anterior half of dorsal; each plate on back and sides with two or more small circular dark spots .... **O. rhinorhynchus.**

b^2. Spine over eye very long, pointing forward; a similar spine below tail, pointing backward (subgenus *Lactoria*) .... **O. cornutus.**

Ostracion gibbosus Linnæus.

Ostracion gibbosus LINNÆUS, Syst. Nat. ed. 10 (1758) 331; GÜNTHER, Cat. Fishes 8 (1870) 258.

Ostracion gibbosum JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 36; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 101.

Ostracion turritus BLEEKER, Atlas Ichth. 5 (1865) 30, pl. 203, fig. 3; DAY, Fishes of India (1878) 695, pl. 181, fig. 4.

Dorsal 9; anal 9; pectoral 10. In a typical specimen, 61 millimeters long, much resembling Day's figure cited above, the depth without the spine is 2.25 times, the breadth 1.5, and the head 3.2 times in the length; eye 1.75 times in snout and $2\frac{3}{8}$ in head.

A much larger specimen, 133 millimeters long, or 167 millimeters including the caudal fin, has the depth 2.5, the breadth 1.87, and the head 4 times in length; the eye is $1\frac{5}{7}$ times in snout and 2.35 in head.

Body roughly triangular, very broad, the ventrolateral ridges expanded, each with four stout, sharp, curved, backward-directed spines, the posterior largest; a small erect spine over each eye, with a ridge running backward toward tail and disappearing beneath and posterior to dorsal; a large broad longitudinal ridge along middle of back, merely roughened in our large specimen, but usually culminating in a very large compressed spine, as in our small example; snout blunt, concave, interorbital space deeply concave; eyes large, nearly circular; dorsal fin immediately behind dorsal ridge and well in advance of anal; gill opening short, below or behind posterior margin of eye; nine plates from gill opening to caudal peduncle; eight plates from middorsal ridge to ventrolateral ridge and eleven plates across widest part of ventral surface.

Color in alcohol brownish yellow, paler yellow beneath, the fins yellow or paler; three or four ill-defined dark brown spots or bars on lower third of body and a similar spot on dorsal spine; base of dorsal, anal, and caudal each with an obscure dark spot. Jordan and Seale [4] state that their specimens were "yellowish white, with about 4 dusky oblique bars on side."

The Bureau of Science specimens above described were collected at Bantayan Island, off the northwest coast of Cebu. The collection also contains a specimen, 20 millimeters long, obtained at Balayan Bay, Batangas.

In the University of Santo Tomas Museum are specimens from Manila Bay and Mindoro; in the Ateneo de Manila Museum is a very fine specimen from Davao, Mindanao, and one from Cebu.

This species has been recorded previously from Cavite on Manila Bay and from Jolo. It occurs from Aden and Zanzibar to Celebes and Amboina.

[4] Loc. cit.

Ostracion tuberculatus Linnæus.

Ostracion tuberculatus LINNÆUS, Syst. Nat. ed. 10 (1758) 331.
Ostracion tuberculatum JORDAN and SEALE, Bull. Bur. Fisheries **26** (1906) 36; EVERMANN and SEALE, Bull. Bur. Fisheries **26** (1906) 101.
Ostracion argus RÜPPELL, Fische des Rothen Meers (1828) 4, pl. 1, fig. 1.
Ostracion cyanurus RÜPPELL, Fische des Rothen Meers (1828) 4, pl. 1, fig. 2.
Ostracion immaculatus SCHLEGEL, Fauna Japonica, Poiss. (1846) 296.
Ostracion immaculatum JORDAN and FOWLER, Proc. U. S. Nat. Mus. **25** (1902) 280.
Ostracion tetragonus BLEEKER, Atlas Ichth. **5** (1865) 39, pl. 201, fig. 2, and pl. 203, fig. 2.
Ostracion cubicus GÜNTHER, Cat. Fishes **8** (1870) 260; Fische der Südsee **3** (1910) 453; DAY, Fishes of India (1878) 696, pl. 181, fig. 3.

Local name: *Tabayong*, Visayan.

Dorsal 10; pectoral 10; anal 10. A typical specimen, 330 millimeters long, has the depth 2.87 times, the width across top 3.75, across bottom 3.47, and the head a trifle more than 6 times in length; snout contained 1.14 times in head; eye 3.1 in head, 2.7 times in snout, and 1.5 times in gill slit.

In another specimen, 130 millimeters long, the depth is 2.5, the top width 3.17 and the bottom width 2.6 times, and the head about 3.9 times in length; snout 1.32 times in head, eye 2.44 times, and 1.9 times in snout; length of gill slit less than diameter of eye.

The spineless, somewhat elongate body is roughly rectangular with four blunt ridges, more prominent posteriorly than at forward end; in small specimens the greatest width nearly or quite equals depth; back more or less elevated along its middle, but there is no ridge except in some examples which have an ill-defined one before dorsal; snout boldly convex in all except small specimens, in which it is pronouncedly concave; there is a hump just above upper lip in all my examples, broad and very marked in large specimens; interorbital space concave; nine plates from gill slit to caudal peduncle, five plates across back, five or six across side, and seven or eight across widest part of underside; anal immediately behind dorsal; caudal peduncle moderately long and strong, its depth 2 or 2.5 times in head, caudal fin a little more than 0.25 of the rest of the animal; gill slit lies entirely behind eye or the anterior end may be below posterior margin of eye.

Color in alcohol brownish or brownish yellow, with a large ocellus on each back and side plate; the ocelli may appear as pale silver spots or more commonly as large dark brown spots with a pale center; more rarely they occur on the belly; head, including the skin around eyeball, underparts, and lower portion of sides more or less sprinkled with small dark brown spots; in young specimens these may also occur on back and caudal peduncle; caudal fin spotted or pale, the other fins all pale; the muscular base of dorsal has three rows of small circular dark spots on each side, or they may disappear in the preservative; the very young have large dark spots scattered over the whole surface.

In life the color is yellow or olive brown, usually with a blue, dark-edged ocellus on each dorsal and lateral scute, and with other spots as already stated.

I have examined seven Philippine specimens varying in length from 98 to 330 millimeters, obtained at Puerto Galera, Mindoro; Simara Island; Cabalian, Leyte; Zamboanga, Mindanao; and Samal Island, in Davao Gulf. I have also examined two specimens from Guam, 32 and 51 millimeters long, respectively. Specimens have been collected previously in the Philippines at Cavite on Manila Bay, Luzon, and at Jolo, Sulu Province. My largest specimen has a total length, including the caudal fin, of a little more than 400 millimeters.

This trunkfish occurs from the Red Sea and Mozambique, on the east coast of Africa, eastward throughout the East Indies, north to Japan and Marcus Island, and south to the Fiji and Samoan Islands.

In their discussion of Japanese trunkfishes Jordan and Fowler[5] state concerning *Ostracion immaculatum* Schlegel—

> * * * It is probably a subspecies of *Ostracion tuberculatum* as Bleeker has indicated, or even it may be the same species with it, as Günther regards it. We give it provisional rank as a distinct species because all our specimens are deeper in body than *O. tuberculatum.*

According to my specimens and measurements this difference will not hold, but there is a difference in the number of plates in the armor, Bleeker's and Day's figures agreeing with mine while Jordan and Fowler's count is more. Until I can compare a series of Japanese and East Indian specimens, I must agree with Bleeker that the Japanese form is not worthy of more than subspecific rank.

[5] Loc. cit.

Ostracion rhinorhynchus Bleeker.

Ostracion rhinorhynchus BLEEKER, Verh. Bat. Gen. 24 (1852) 34, pl. 6, fig. 12; Atlas Ichth. 5 (1865) 37, pl. 201, fig. 1, and pl. 203, fig. 1; GÜNTHER, Cat. Fishes 8 (1870) 263.

Dorsal 9; anal 9; pectoral 10. Depth equals width across top and is 2.63 times in length; width across bottom $\frac{1}{6}$ greater or 2.2 times, and head 3.16 times in length; snout 1.47 times in head, eye 2.5 times, and 1.7 in snout; gill slit 2.5 times in eye; nine plates between gill slit and caudal peduncle, five across back, six in a transverse row on side, and nine across bottom; caudal peduncle thin, narrow, its depth 3.57 in head, caudal fin small, 4.15 times in length.

Body deep, four-sided, somewhat ovate, without spines, with concave sides, and strongly produced lateral ridges; a low ridge along middle of back; interorbital space slightly concave, snout convex; the small diagonal gill slit just behind eye; anal larger than, its origin forward of middle of, dorsal.

Color in alcohol gray brown, sprinkled everywhere except on ventral surface with small circular dark spots, one to five on each plate in my specimen; similar spots on the circumference of eyeball, the muscular base of pectoral, caudal peduncle, and tail fin; other fins pale.

Here described from a specimen 79 millimeters long, or 98 millimeters long over all, collected at Estancia, Iloilo Province, Panay, by H. R. Montalban.

This well-marked species has from two to ten spots on the plates and reaches a length of nearly 350 millimeters. With age the convexity on the snout becomes a large conical hump projecting forward. It has been recorded from Pinang, Java, Billiton, Celebes, Solor, Ceram, and the northwest coast of Australia.

In the University of Santo Tomas Museum are two specimens from Manila Bay, the largest 330 millimeters long over all, and one each from Cebu and Jolo.

Ostracion cornutus Linnæus.

Ostracion cornutus LINNÆUS, Syst. Nat. ed. 10 (1758) 331; SCHLEGEL, Fauna Japonica, Poiss. (1846) 299, pl. 131, fig. 4; GÜNTHER, Cat. Fishes 8 (1870) 265; DAY, Fishes of India (1878) 697, pl. 176, fig. 4; GÜNTHER, Fische der Südsee 3 (1910) 457, pl. 171 and 10 text figures.

Ostracion arcus BLEEKER, Atlas Ichth. 5 (1865) pl. 202, fig. 3, and pl. 204, fig. 4.

Ostracion cornutum JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 282; JORDAN and SEALE, Bull. Bur. Fisheries 25 (1906) 36; EVERMANN and SEALE, Bull. Bur. Fisheries 25 (1906) 101.

Local names: *Baca-baca,* Filipino Spanish; *pega-pega,* Tao Sug. Cowfish, cuckold, English; *vaca,* Spanish.

Dorsal 9; anal 8 or 9; pectoral 10. Depth $2\frac{1}{3}$ to 2.8 times, head 2.86 to $3\frac{3}{8}$ times in length; greatest width across top from 3.5 to 4.1 in length and $1\frac{3}{8}$ times in greatest width of ventral side, which is 2.1 to 2.64 in length; snout approximately equals greatest width of upper surface of body and is 1.1 to 1.2 in head; eye 2.1 to 2.35 in head and 1.76 to 2.14 in snout; depth of caudal peduncle usually equals eye but may be only 0.65 of its diameter.

Body irregularly rectangular with slightly convex belly, and dorsolateral and ventrolateral ridges not strongly marked; there is a low, narrow, often poorly defined median ridge along dorsal surface; a pair of very long, sharp, forward-pointing, and more or less divergent spines project from the large supraorbital ridges, and a pair of similar backward-pointing spines at posterior extremity of the ventrolateral ridges; a blunt, outwardly directed median spine on each dorsolateral ridge and a similar but much smaller spine between them on the median dorsal ridge; head very deep, its nearly vertical profile slightly undulate and slightly concave, mouth very low, pointing downward; interorbital space deeply concave; gill slit much less than an eye diameter in length and far behind eye; anal fin far behind dorsal; caudal fin very long, half or more than half the length of head and trunk together.

Color in alcohol usually brownish, belly paler, without markings; other specimens gray, grayish brown, or yellowish, one grass green; caudal and sometimes caudal peduncle with large dark spots; in most specimens there are at least traces of a broad dark interorbital band, continued over snout and between mouth and pectoral; a dark blotch below pectoral; a dark band across widest part of back and continued on sides to ventral margin; a similar band from base of posterior ventral spine up over side and across back at dorsal, connecting on middle of side and on dorsal surface with the other crossband. The blue or dark spots described by authors are absent

in all specimens except a dried one, which had a blue spot in the center of each plate except those of the underside.

The color of four living specimens in the Bureau of Science Aquarium is very pale greenish yellow, clouded with dark bands as described for alcoholic material; a bluish or whitish pearly spot on each scale except on belly, which is clear yellow; lips yellowish with a broad blackish line behind them; fin rays very pale, the membranes transparent.

Except when actively swimming about, this preposterously solemn and dignified-looking fish keeps the caudal fin folded, slowly moving about by the incessant and rapid movements of the other fins. The greatly elongated tail fin is a powerful sculling oar when expanded to its full width, which is apparently disproportionate for the rest of the fish.

This fantastic and variable fish is readily recognizable by its horns, which rarely are bifid or crooked; in young specimens the ridges are more pronounced, but in adults they are almost smooth; the caudal becomes proportionately very much larger in old specimens, until eventually it may be nearly as long as the coat of armor; at the same time the "horns" are blunt and proportionately much shorter than in the young. In a specimen from Zamboanga with a length of but 23 millimeters the tail is very short, not extending to the end of the short posterior spine, while the orbital spines are also but little developed; however, in specimens but little larger the anterior and posterior spines become greatly elongated, the latter extending beyond the tip of the caudal fin until the fish attains a length of about 50 millimeters.

I have examined very many specimens, both living and preserved, of this common coral-reef inhabitant, from Puerto Galera and Calapan, Mindoro; Cuyo; Puerto Princesa, Palawan; Zamboanga and Davao, Mindanao; and Jolo. These range in length from 23 to 138 millimeters, the largest being 220 millimeters long with the caudal fin. It has been previously recorded from Cavite on Manila Bay and from the southern coast of Negros, by Jordan and Seale, and is a common curio in all public and private collections and as an ornament in the home.

This species occurs from the Red Sea and Zanzibar to Japan, Marcus Island, and Tahiti. I have a specimen, about 35 millimeters long over all, which was obtained many years ago from the stomach of a dolphin, *Coryphæna* species, caught in the mid-Pacific.

Suborder GYMNODONTES

The plectognaths belonging to this suborder are degraded forms which have lost their scales, spinous dorsal, and separate teeth. In the most-specialized forms the ribs, pelvis, and caudal vertebræ are also lost, so that they present a very singular appearance. The Gymnodontes are so named because the jaws are enveloped in an enamel-like covering, without distinct teeth, which forms a powerful parrotlike beak; the body is short to very short and in all but the Molidæ the belly is more or less inflatable. The scales typically resemble spines or bristles and have rootlike insertions. In this group the development of poisonous alkaloids in the flesh reaches its maximum; other means of defense, well developed in this group of poor swimmers, are the spines and bristles, the power of inflation, and the tough and leathery skin.

Key to the families of Gymnodontes.

a^1. Caudal fin normally developed, with a distinct caudal peduncle.
- b^1. Upper and lower jaws each divided into right and left halves.
  - c^1. Back broadly rounded; head broad; nostrils various; frontal bones united with supraoccipital .... **Tetraodontidæ.**
  - c^2. Back more or less sharply ridged; nostrils obsolete or very small; frontal bones separated from supraoccipital by the postfrontals, which meet in the middle .... **Canthigasteridæ.**
- b^2. Upper and lower jaws each entire; premaxillary and dentary bones grown together, forming jointless arches; maxillaries extended laterally behind; body covered with stout rooted spines.. **Diodontidæ.**

a^2. Body truncated behind dorsal and anal, without caudal peduncle and with the caudal region aborted; jaws without division .... **Molidæ.**

TETRAODONTIDÆ

GLOBEFISHES, PUFFERS, OR SWELLFISHES

Local names: *Botiti* or *botete,* most Filipino languages; *tikung* or *langiguihon,* Visayan; *tinga-tinga,* Tao Sug.

This dangerous group of fishes is widely distributed in warm seas all over the world and is common throughout the Philippines. Although most people are more or less aware of the poisonous properties of the flesh, it is eaten in practically every Philippine fishing village and not a year goes by without several deaths from this cause. A Japanese investigator[6] has

[6] I have been unable to obtain a copy of his paper, which appeared in the Archiv für Pathologie und Pharmacologie.

studied carefully the alkaloid present in the flesh of the Tetraodontidæ and finds it to be very near muscarine, the active poisonous principle of *Amanita muscaria* and other fungi. It is a tasteless, odorless, and very poisonous crystalline alkaloid. The dangerous alkaloid seems to be most abundant and virulent in the eggs or roe and sperm or milt; it is claimed by the fishermen that the gall bladder is also very poisonous. Many Filipinos believe that if the entrails and skin are removed from *botiti* the flesh is wholesome. While this may be more or less true, especially when the breeding season is not near, it is nevertheless very dangerous to eat the flesh of botiti, and their sale and use should be forbidden.

The body is oblong to elongate, usually but slightly compressed, and may be very broad, especially the head and snout; the belly is capable of great inflation, the animal swallowing air when disturbed or frightened, and then floating on the surface belly up, a trait which gives the fish its common name. The fishes of some species are able to swell up so much that they become helpless globes with beak and tail attached at opposite poles. The skin is scaleless, more or less prickly or bristly, the spines or prickles usually weak and movable; rarely the skin is armed with bony scutes, forming a sort of carapace. Many authors have laid much stress upon the bristles and spines, their length and presence or absence, while the presence of a coat of long furlike bristles in some specimens and the almost total absence of bristles in others of the same species has been puzzling to many. The reason for this variation is merely that these fishes have the power of extruding and withdrawing their defensive bristles at will.

The lips are full and the jaws form a broad prominent bony beak, each half divided by a median suture; the maxillaries are curved outward behind the premaxillaries. The spinous dorsal is lacking, the fins being composed of soft rays only; the dorsal fin is posterior, opposite and similar to the anal; the caudal fin is distinct and well developed; the pelvic bones are undeveloped, the ventral fins therefore absent; there are no ribs; the pectoral fins are short and broad, their upper rays longest; the gill openings are small, in front of and close to the pectorals; an air bladder is present; the vertebræ are few in number, 7 or 8+9 to 13.

Key to the Philippine genera of Tetraodontidæ.

a^1. Nostril on each side with two distinct openings, usually in a low tube or papilla .... **Spheroides.**

a^2. Nostrils without openings.

b^1. Nostril a simple unperforated cavity with two marginal flaps or fringed margin.. **Chelonodon.**

b^2. Nostril on each side a bifid tentacle without opening........ **Tetraodon.**

Genus SPHEROIDES Lacépède

The oblong or elongate body is covered more or less by prickles or bristles; there is a single short simple nasal tube on each side, with two distinct or rather large openings near its tip, or the tube may be reduced to a mere rim; the frontal bones are expanded laterally and from the lateral roof of the orbit, the postfrontals limited to the posterior portions; the abdomen is capable of very great distension; in some species there is a distinct fold of skin along the lateroventral portion of the body, especially on the posterior region; vertebræ eighteen to twenty-one.

The genus is a large one, chiefly tropical, and some of the species reach a comparatively large size. In this genus I include *Lagocephalus* of authors, with elongate body, silvery skin, and prominent lateral fold, as well as the typical *Spheroides* with the shape of *Tetraodon,* since there are transitional forms covering every gradation from one extreme to the other. Some of the species are exceedingly poisonous.

Key to the Philippine species of Spheroides.

a^1. No black, white-margined spots or bands on back.

b^1. Color above pale brown, thickly sprinkled with small circular dark spots .... **S. sceleratus.**

b^2. Back not covered with circular dark spots.

c^1. Back uniform brown to pale gray.. **S. lunaris.**

c^2. Back not uniform but variously banded and spotted.

d^1. Back brown, with many white or light irregular spots; sides with transverse brown bands and light bars alternating. **S. oblongus.**

d^2. Back dark brown, extending to middle of sides as a sharply defined blanket, with white or milky spots and many fine white lines and specks; three or four dark brown crossbars on cheeks. **S. hypselogeneion.**

a^2. A large, black spot behind each pectoral, connected by a black band, the whole surrounded by a white margin; a black, white-edged spot at base of dorsal.. **S. ocellatus.**

Spheroides sceleratus (Forster).

Tetraodon sceleratus (Forster) GMELIN, Syst. Nat. (1788) 1444.

Spheroides sceleratus JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 234.

Tetrodon sceleratus GÜNTHER, Cat. Fishes 8 (1870) 276; Fische der Südsee 3 (1910) 461.

Tetrodon argenteus LACÉPÈDE, Ann. Mus. Hist. Nat. (1804) 211, pl. 58, fig. 2; SCHLEGEL, Fauna Japonica, Poiss. (1847) 275, pl. 121, fig. 2; BLEEKER, Atlas Ichth. 5 (1865) 64, pl. 209, fig. 1.

Dorsal 12; anal 11. Depth contained 5 times, head 2.88 times in length; eyes very large, elongate, 3 times in head, 1.4 times in snout, and 1.17 times in the flat interorbital space; snout 2.16 times, interorbital 2.6 times in head; caudal peduncle elongate, very low, its least depth 10.4 times in head; caudal fin contained 6 times in head and trunk.

Body elongate, slender, with long and roughly rectangular, laterally compressed head and depressed tail; the whole body, except lips, tail, and a strip along the side from pectoral backward, covered with prickles.

Color in alcohol pale brown above, thickly sprinkled with small dark brown circular dots and spots; a silvery band along sides and below it a narrow brownish band running around chin, the underparts white; a triangular silvery spot in front of each eye; gill openings blackish.

Here described from a specimen 150 millimeters long, collected at Basilan. This species was obtained in the Philippines by the celebrated English collector Hugh Cuming; it is well known to the Moros, and several deaths from eating it have been reported from time to time, especially about Basilan. It is apparently rare elsewhere in the Philippines.

This dangerous fish occurs from Zanzibar and Cape Guardafui eastward to Australia and Tahiti and northward along the Asiatic coast to southern Japan. It attains a length of approximately 700 millimeters.

Spheroides lunaris (Bloch and Schneider). Plate 2, fig. 4.

Tetrodon lunaris BLOCH and SCHNEIDER, Syst. Ichth. (1801) 505; SCHLEGEL, Fauna Japonica, Poiss. (1847) 277, pl. 122, fig. 1; GÜNTHER, Cat. Fishes 8 (1870) 274; DAY, Fishes of India (1878) 701, pl. 182, fig. 2.

Tetraodon lunaris BLEEKER, Atlas Ichth. 5 (1865) 63, pl. 205, fig. 2.

Spheroides lunaris JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 790; Bull. Bur. Fisheries 26 (1906) 36; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 101; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 248; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 1908.

Tetrodon spadiceus RICHARDSON, Zool. Voy. Sulphur, Ichthyology (1845) 123, pl. 58, figs. 4 and 5; BLEEKER, Atlas Ichth. **5** (1865) 64, pl. 207, fig. 1; JORDAN and SNYDER, Proc. U. S. Nat. Mus. **24** (1901) 234.

Local name: *Botiting saguing,* Tao Sug.

Dorsal 12; anal 11–12. Head contained 2.6 to 3 times, caudal fin 2.9 to 4.4 times in length; snout from 1.94 to 2.2 times in head; eye 2.8 to 4 times in head, 1.2 to 1.9 in snout, and equal to or 1.7 times in interorbital, the last named 2.1 to 2.9 times; caudal peduncle from 4.1 to 6.1 times in head; normal depth equal to or less than length of head.

Body elongate, oblong, head and trunk strongly flattened along sides, caudal peduncle long, low, more or less cylindrical; snout convex, blunt, interorbital space slightly concave or flat; back low, slightly convex or little elevated, rather flattened, but with a keel before dorsal fin; eyes very large, placed very high up; upper teeth prominent, projecting over lower; small, somewhat closely set spines on back, extending from the region behind nostrils to dorsal; a patch of similar but coarser and more widely spaced spines on belly, from a point below nostrils nearly to anus; rest of body spineless; a distinct ridge or fold of skin beginning on chin and extending back along the side above belly to base of caudal fin, which is lunate; belly may be very greatly distended, the depth then 1.5 times the length of head.

The color in alcohol varies from uniform brown above to pale mouse gray on back; a broad silvery white band on sides from snout to tail; underparts white or yellowish; the fins are all pale or the posterior part of caudal may be dark; iris yellow.

Here described from very many specimens, varying in length from 30 to 240 millimeters, from the following localities: Alaminos, Pangasinan; Manila and Cavite, Manila Bay; Balayan Bay, Batangas; Guinyangan, Bondoc Peninsula, Tayabas; and San Miguel Bay, Camarines, all in Luzon; Estancia and Barotac Nuevo, Panay; Cebu, Cebu; Cagayan de Misamis, Mindanao; Amoy and Hongkong, China; and Sandakan, Borneo. Some of these are typical *lunaris,* others the *spadiceus* of Bleeker, but there are all stages of intergrading forms between, so that I am compelled to unite them. The best distinguishing character is the lateral line in its course beneath the eye, but specimens of the same lot often show great variation in this respect, so that it, too, is valueless. Previously this fish has been noted

in the Philippines from San Fabian, Pangasinan Province, Luzon; Iloilo, Panay; Oriental Negros; and Zamboanga, Mindanao.

This species attains a length of more than 300 millimeters, and is very abundant throughout the East Indies, from whence it ranges westward to the coasts of Hindustan and the Red Sea and northward to Japan.

Spheroides oblongus (Bloch).

Tetrodon oblongus BLOCH, Ichthyologie **5** (1787) 4, pl. 146, fig. 1; BLEEKER, Atlas Ichth. **5** (1865) 62, pl. 208, fig. 4; GÜNTHER, Cat. Fishes **8** (1870) 278; DAY, Fishes of India (1878) 702, pl. 182, fig. 3.

Spheroides ocellatus JORDAN and SEALE, Proc. U. S. Nat. Mus. **28** (1905) 791 (not of Osbeck); Bull. Bur. Fisheries **26** (1906) 36 (not of Osbeck).

Dorsal 13; anal 11. Depth uninflated equals length of caudal fin or 2.7 to 3.5 times in head and trunk; head contained 2 to 2.64 times in length; eye of moderate size, 4 to 4.85 times in head; 1.7 to 2.25 times in snout, and 2.25 to 2.5 times in interorbital space, and equal to, or two-thirds of, depth of caudal peduncle; snout 2.5 to $2\frac{1}{3}$ times, interorbital space 1.75 to almost twice in head.

Body stout, oblong, wedge-shaped, with compressed sides, a short, bluntly triangular, slightly convex to slightly concave snout, a flat or concave interorbital space, slightly arched or nearly flat back, and a very distensible belly; upper and lower teeth about equal in size; caudal fin truncate, rather small; very small and mostly widely spaced spines present everywhere except on lips, snout in front of nostrils, and that part of body lying posterior to origin of dorsal.

Color in alcohol brown above, with many white or pale irregular spots, the brown descending on sides in irregular transverse bands with white bars ascending between them posteriorly; the band behind pectorals and the one including base of dorsal very broad and much darker than the rest; a silvery yellowish band on sides and continuous around chin, belly white; tip of caudal blackish, the rest of the fins pale or yellowish.

Here described from two specimens, one 74 millimeters long, from Masbate; the other 78 millimeters long, from Panacan, Palawan. I have also examined a specimen sent for determination from Amoy, China, collected by S. F. Light.

This very handsome botiti runs into several well-marked varieties, some of which may be true species, but my few speci-

mens are quite typical. This species reaches a length of nearly 400 millimeters and occurs along the southern coasts of Asia from India to Amoy, and northeastward through the Sunda Islands to the Philippines. According to Seale, it occurs at Faté, one of the New Hebrides group.

Spheroides hypselogeneion (Bleeker).

Tetrodon hypselogeneion BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 300; Atlas Ichth. 5 (1865) 61, pl. 213, fig. 5.

Spheroides hypselogeneion JORDAN and SEALE, Bull. Bur. Fisheries 25 (1905) 368; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 100.

Tetrodon hypselogeneion GÜNTHER, Cat. Fishes 8 (1870) 277, in part; DAY, Fishes of India (1878) 702, pl. 183, fig. 5; GÜNTHER, Fische der Südsee 3 (1910) 462, pl. 172, fig. A.

Dorsal 8; anal 7 or 8. Head 2.5 or 2.6 times, caudal 3.2 to 3.4 times in length; snout 2 to 2.5 times in head; eye equals or slightly exceeds interorbital space, $3\frac{2}{3}$ to $3\frac{3}{4}$ times in head; depth of caudal peduncle 4 to 5 times in head.

Body oblong, wedge-shaped, somewhat elongate, its greatest depth at gill openings, sides compressed, head and snout pointed; upper profile straight, interorbital space convex, back nearly flat; upper teeth nearly as large as lower; short, stout, coarse, widely spaced prickles cover entire body except lips and tail behind dorsal fin and anus; chin heavy, broad, angular; caudal truncate; belly moderately distensible.

Color in alcohol dark brown on back and extending as a sharply defined blanket to middle of sides, sprinkled with irregular white or milky spots and very many fine white lines and specks; a silvery white band along sides, the parts below all yellowish or whitish posteriorly; three or four dark brown crossbars on side of head, one on snout, one before and below eye, one just behind eye, and one before gill opening; the fins are all pale.

Here described from five specimens from Panacan, Palawan, and two from Davao, Mindanao. They are all small, ranging from 26 to 52 millimeters in length. Since this was in type I have received four specimens, 30 to 46 millimeters in length, from Odiongan, Tablas. The only previous Philippine record of this handsome little puffer is from Bulan, Sorsogon Province, Luzon. It occurs from the Red Sea and Zanzibar to the Fiji, Samoan, and Navigator Islands, and attains a length of about 200 millimeters.

Spheroides ocellatus (Osbeck).

Diodon ocellatus OSBECK, Iter Chinensis (1757) 226, or Eng. trans. 1 (1771) 364, 2, 331.

Tetrodon ocellatus LINNÆUS, Syst. Nat. ed. 12, 1 (1766) 411; BLOCH, Ichtyologie 5 (1787) 1, pl. 145; RICHARDSON, Zool. Voyage Sulphur, Ichthyology (1845) 120, pl. 58, figs. 1, 2, 3; GÜNTHER, Cat. Fishes 8 (1870) 279.

Spheroides ocellatus JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 243.

Dorsal 14; anal 12. Head equals depth, 3 times in length; body rather robust, back covered with minute spines from near nostrils to dorsal fin; abdomen entirely covered with somewhat coarser spines, the rest of the fish smooth and naked; lateral ridge obscure; caudal truncate.

In alcohol the color above is olivaceous, with silvery sides, and pale underparts; there is a large black spot behind each pectoral, the two connected by a black band over back, the band and spots surrounded by a white margin; a black, white-edged circular spot or blotch at base of dorsal.

I have not seen this species, and the description above is altered from that given by Jordan and Snyder. *Spheroides ocellatus* is abundant about Canton and ranges north to Japan. It has been reported by Jordan and Seale from Manila and from southern Negros. Osbeck found it in Canton River and, according to Bloch and Schneider, it inhabits fresh water in the vicinity of the sea.

Since the above was in type I have found a specimen in a miscellaneous lot of fishes, collected by students of the University of the Philippines, of which the exact locality is unknown. This specimen, which is a duplicate of Richardson's figure 3 cited above, is 57 millimeters long; the head is 21 millimeters long, the depth 15 millimeters. There are thirteen rays in the dorsal and eleven in the anal.

Genus **CHELONODON** Müller

Chelonodon MÜLLER, Abhandl. Akad. Wiss. Berlin (1839) 252.

This genus is distinguished from other Tetraodontidæ by the nostrils, which are simple unperforated cavities surrounded by a very short membranous tube which is extended into two or more flaps or a fringelike margin. Two species are known, confined to southern and southeastern Asia and the East Indies.

Chelonodon patoca (Buchanan-Hamilton).

Tetrodon patoca BUCHANAN-HAMILTON, Acct. Fishes River Ganges (1822) 7 and 363, pl. 18, fig. 2; GÜNTHER, Cat. Fishes **8** (1870) 288; Shore Fishes Challenger, Zoölogy 1[6] (1880) 54; DAY, Fishes of India (1878) 703, pl. 182, fig. 4.

Chelonodon patoca SMITH and SEALE, Proc. Biol. Soc. Washington **19** (1906) 79; SEALE and BEAN, Proc. U. S. Nat. Mus. **33** (1907) 248; JORDAN and RICHARDSON, Bull. Bur. Fisheries **27** (1907) 274.

Leiodon patoca BLEEKER, Atlas Ichth. **5** (1865) 76, pl. 210, fig. 2.

Dorsal 9–10; anal 8, 9. Head contained 2.4 to 2.6 times, depth 2.75 to 3.35 in length; eye about 4.3 to 4.85 (2.8 in young), snout 2 to 2.25, interorbital space 1.8 to 2, and caudal peduncle 2.8 to 3.25 in head.

Body stout, wedgelike, somewhat cylindrical or rectangular anteriorly and laterally, compressed posteriorly, with large obtuse head, blunt convex snout, and very broad interorbital space; eyes large, prominent; nasal opening a shallow pit with a bilobed or somewhat fringed margin; upper jaw prominent, projecting beyond lower; back covered with small spines, from behind interorbital space to dorsal fin; similar spines on belly and up on sides to base of pectorals; belly can be greatly distended; tip of caudal rounded.

In alcohol the back is brownish to very dark or blackish brown, with numerous round or oval whitish spots which extend well down upon sides; sides more or less silvery, the underparts white; a dark band across interorbital space; three dark bands across dorsal surface and descending upon sides, one behind pectorals, one including base of dorsal, and one on caudal peduncle; fins all clear except outer portion of caudal, which is dark.

I have examined very many alcoholic specimens from the following localities: Abra River, Ilocos Sur; Agno River, Pangasinan; Manila; Cavite; San Miguel Bay, Camarines Sur, all on Luzon; Calapan, Mangarin, and Pinamalayan, Mindoro; Estancia, Panay; Guinobatan, Masbate; Borongan, Samar; Cabalian, Leyte; Agusan River, Cagayan de Misamis, Davao, Placer, and Zamboanga, Mindanao; Balabac. The specimens referred to above are all small, ranging in length from 21 to 90 millimeters. Another specimen from Tacligan, Mindoro, 153 millimeters long, lacks the many small round whitish spots on sides and back, but has large white areas on the sides between the dark crossbands.

Four living specimens from Calapan, Mindoro, are yellowish or greenish olive with five very dark crossbands, the first across the interorbital space and extending below the eye as a divided band, one part diagonally forward, the other downward; the second is wide and lies behind the gills; the third is faint, midway on the back; the fourth includes the dorsal base and descends on side nearly to belly; the fifth is on the caudal peduncle; a silvery longitudinal band extends from side of head along body below pectoral to caudal; below this is a yellow strip; scattered over the back and especially on caudal peduncle are circular white spots.

This common fish, which attains a length of about 330 millimeters, occurs in shallow water along the coasts everywhere and enters rivers as far as the tides affect them. It is subject to a considerable amount of variation in color, but there is always at least a trace of the characteristic spots on the back or the posterior portion of the sides; the spots are said to be sometimes yellow. It occurs from Hindustan, where it was originally described from the Ganges, to China and eastward in the East Indies to Amboina, Ceram, Batjan, and Ké.

Genus **TETRAODON** Linnæus

The robust body is covered with more or less prickly or bristly skin; each nostril is provided with a tentacle which is divided into two lobes to its base, their tips without openings, the branches of the large olfactory nerve ending in cuplike depressions along the inner edges of the two somewhat flattened lobes; the eye is surrounded by a ring muscle which forms eyelids; vertebræ usually $8 + 10 = 18$.

The members of this genus are very dangerous when eaten. Because they are often abundant and easily caught there are always some who will run the risk of eating them. The medical Journal of Australia, under date of December 1, 1923, tells of two Malays who ate a species of *Tetraodon*, although warned of the danger. They ate at noon with no serious effects but on eating some for supper they were taken violently ill, one dying in an hour, the other about three hours later.

Key to the Philippine species of Tetraodon.

a^1. Upper and lower margins of caudal always black; no spots on body, which may be uniform olive or brown above, or with longitudinal parallel lines over whole body or on back................ **T. immaculatus.**

a^2. Margins of caudal not black; body always spotted.
b^1. Spots white.
c^1. No large irregular black spots on sides.
d^1. Back dark with small white spots or lines; curved or longitudinal lines on sides and belly; white lines curving upward around gill openings; caudal spotted to its tip.... **T. reticularis.**
d^2. Large circular white spots on upper half of body and anterior part of caudal; belly uniform white or with narrow stripes. **T. hispidus.**
c^2. Several large irregular black spots on sides below pectorals; upper half with long wavy irregular dark brown lines inclosing circular white spots; lines on side of head vertical or radiating from eye........ **T. mappa.**
b^2. Spots dark.
e^1. Anus in a black spot.
f^1. Spines black; dorsal region covered with circular spots or else pure black; caudal black spotted........ **T. aerostaticus.**
f^2. Spines white; body with a few large irregular black spots, especially on belly; caudal not spotted........ **T. nigropunctatus.**
e^2. Anus not in a black spot; upper part of body with many large dark brown circular spots........ **T. fluviatilis.**

Tetraodon immaculatus Bloch and Schneider.

Tetraodon immaculatus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 507; JORDAN and SEALE, Proc. U. S. Nat. Mus. **28** (1905) 790; Bull. Bur. Fisheries **26** (1906) 37; EVERMANN and SEALE, Proc. U. S. Nat. Mus. **31** (1907) 510; SEALE and BEAN, Proc. U. S. Nat. Mus. **33** (1908) 248; JORDAN and RICHARDSON, Bull. Bur. Fisheries **27** (1907) 273; WEBER, Fische der Siboga Exp. (1913) 584.

Tetrodon immaculatus GÜNTHER, Cat. Fishes **8** (1870) 291; DAY, Fishes of India (1878) 703, pl. 183, fig. 4; GÜNTHER, Shore Fishes Challenger, Zoölogy 1[6] (1880) 54; Fische der Südsee **3** (1910) 464.

Tetraodon sordidus RÜPPELL, Neue Wirbelt., Fische (1835) 60, pl. 16, fig. 4.

Tetraodon scaber EYDOUX and SOULEYET, Voy. Bonite, Poissons (1841) 214, pl. 10, fig. 1.

Crayracion immaculatus BLEEKER, Atlas Ichth. **5** (1865) 75, pl. 211, fig. 1.

Tetrodon manillensis PROCÉ, Bull. des Sciences, Soc. Philomat. (1822) 130.

Crayracion manillensis BLEEKER, Atlas Ichth. **5** (1865) 69, pl. 208, fig. 2.

Tetrodon virgatus RICHARDSON, Voy. Erebus and Terror, Zoölogy, Fishes (1846) 62, pl. 39, figs. 8 and 9; Voy. Herald, Zoölogy, Fishes (1854) 163, pl. 28, figs. 6 to 8.

Local name: *Mosi*, Visayan.

Dorsal 10; anal 9. Head contained 2.6 to 2.7 times in length; eye 3.7 to 4.75 in head, snout 2.1 to 2.2, interorbital space 1.7

to 2.1, depth of caudal peduncle 2.7 to nearly 3; breadth of body equal to its depth when not inflated and equal or nearly equal to head.

Body elongate wedge-shaped, with a broad stout conical head, the whole fish more or less laterally compressed; snout short, blunt, upper profile straight, chin full, rounded, and projecting; interorbital space broad, flat; nostril filaments large, conspicuous, two-lobed; caudal fin large, its length more or less than that of head; the whole body thickly covered with white or pale bristles, except upon lips and posterior portion of tail. The belly is capable of very great distention. In a number of specimens the body is nearly globose, like an inflated toy balloon, the depth and breadth each $\frac{6}{7}$ of the length.

Color in alcohol gray, brownish to very dark brown above, paler to white under chin and on belly; my specimens all have twelve to twenty or more bluish or blackish parallel longitudinal lines more or less plainly visible on back, sides, and belly, those on the latter usually soon fading; nasal tentacles white; upper and lower margins of caudal always black, posterior end dark; base of pectoral and dorsal very dark, fins pale; lips yellow; often one or more white spots near eyes.

I have examined over forty alcoholic specimens in the Bureau of Science collection, ranging in length from 14 to 107 millimeters, collected in the following localities: Malabon, Manila, and Cavite, Luzon; Mangarin, Mindoro; Bantayan Island; Cebu, Cebu; Busuanga Island; Dumaguete, Oriental Negros; Cabalian, Leyte; Gigaquit, Surigao Province, Cagayan de Misamis, Zamboanga, and Davao, Mindanao; Sitanki; and Sandakan, Borneo.

There are ten living specimens in the Bureau of Science Aquarium, all collected at Calapan, Mindoro, which show considerable variation in color. The back may be dusky gray, mouse color, or silvery brown-gray, with pale belly; the longitudinal lines are usually greenish yellow or golden; in two specimens they are a kind of red on the back, on the belly yellow; a yellow line surrounds the mouth; the fins are nearly colorless or pale yellow.

I have also examined two dried specimens from Manila and one from Batangas, in the University of Santo Tomas Museum, ranging in length from 230 to 305 millimeters.

All the above-mentioned specimens belong to Procé's *T. manillensis*, or variety *virgata* of Günther, none of them showing the adult color state in which the body is uniformly colored, olive or

brownish above and paler below, without spots or bands, though in one or two of the living specimens the longitudinal lines have nearly disappeared. These color phases often seem to have no relation to size or maturity, though the striped form is probably usually immature.

A specimen 203 millimeters long, or 269 millimeters over all, collected at Calapan, Mindoro, is nearly black above, becoming brownish olive on the sides and yellowish white beneath; the bases of the pectorals and dorsal are black, the dorsal dusky; the caudal has a black margin; the pectorals and ventral are yellowish. This specimen likewise differs in its proportions; the head is a trifle more than 3 times in the length; the eye 5.5 in the head and 2.5 in the blunt, very slightly concave snout, which is 2.1 in the head; the interorbital space is very wide, nearly flat, 1.73 in the head; the depth of the caudal peduncle is 2.4 in the head; the caudal fin is very wide with rounded tip, its length equal to the head.

This species has been collected by every naturalist visiting the Philippines during the past century or more. In addition to the localities already named it has been listed from Lubang; Ticao; Iloilo; Cuyo; Sanguisiapo in the Sulu Archipelago; and from the Sulu Sea.

This highly poisonous fish, especially the striped form first described above, is very common in the Philippines; it occurs from the Red Sea and Zanzibar, eastward and southward to northern Australia and throughout Polynesia.

Tetraodon reticularis Bloch and Schneider.

Tetraodon reticularis BLOCH and SCHNEIDER, Syst. Ichth. (1801) 506; JORDAN and SEALE, Proc. U. S. Nat. Mus. **28** (1905) 791; Bull. Bur. Fisheries **26** (1906) 37; SEALE and BEAN, Proc. U. S. Nat. Mus. **33** (1908) 248; JORDAN and RICHARDSON, Bull. Bur. Fisheries **27** (1907) 73.

Tetrodon reticularis GÜNTHER, Cat. Fishes **8** (1870) 296; DAY, Fishes of India (1878) 705, pl. 180, fig. 5; GÜNTHER, Fische der Südsee **3** (1910) 466.

Tetrodon testudineus BLOCH, Ichtyologie **4** (1787) 122, pl. 139 (not of Linnæus), pro parte.

Crayracion testudineus BLEEKER, Atlas Ichth. **5** (1865) 71, pl. 212, fig. 3.

Dorsal 10; anal 10. Head contained 2.3 to 2.4 times in length; eye about 4 to more than 5, snout 2 to 2.3, interorbital 1.9 to 2, and depth of caudal peduncle 2.87 to 3.1 times in length of head.

Body oblong wedge-shaped, little compressed except the caudal peduncle, head large, blunt, and very broad with conical snout more or less convex in profile, and broad muzzle; the broad interorbital space slightly convex, dorsal region back to dorsal fin rather strongly so; nasal filaments conspicuous, coarsely bilobed; caudal fin of moderate size; the whole body, except lips, covered with white bristles. The belly can be distended until it is nearly globose.

Color in alcohol blackish or dark brown with many small white spots or lines above, larger and more conspicuous behind pectorals and on caudal peduncle, passing into long curved or longitudinal lines on sides and belly; white lines partially encircling eyes and curving around gill openings; caudal conspicuously spotted to its tip, the other fins clear whitish or yellowish, with dark or blackish bases; lips whitish.

Here described from a specimen 81 millimeters long, collected by A. L. Day somewhere in the Visayas; and a specimen 112 millimeters long from Samal Island in Davao Gulf, Mindanao. The species has been recorded previously from the Philippines from Cavite, Luzon; Negros; Lubang; and Zamboanga, Mindanao. In the museum of the Ateneo de Manila is a specimen from Cebu, 340 millimeters long, or about 440 millimeters over all. In the University of Santo Tomas Museum are several specimens from Manila Bay, Mindoro, and Cebu; the largest, without definite locality, has a length of 430 millimeters, or 550 millimeters including the caudal fin.

This distinctively marked poisonous fish occurs from the coasts of India to Guam, New Guinea, and New Britain.

The color of a living specimen in the Bureau of Science Aquarium, collected at Calapan, Mindoro, is greenish yellow, with dark brownish yellow lines on belly, sides, and back; these pass into white spots posteriorly on the sides and above; yellowish lines curve upward between and around the gill openings and eyes; the caudal fin is reticulated yellowish and whitish, the other fins all yellowish. As the proofs were being corrected two specimens were caught with hook and line from the dock at Manila and are now alive in the aquarium.

Tetraodon hispidus Linnæus.

? *Tetraodon hispidus* LINNÆUS, Syst. Nat. ed. 10 (1758) 333; BLOCH, Ichtyologie 4 (1787) 131, pl. 142; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 251; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23[1] (1903) (1905) 427, pl. 66; JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 37; JORDAN and RICHARDSON, Bull. Bur.

Fisheries 27 (1907) 273; WEBER, Fische der Siboga Exp. (1913) 585.

Tetrodon hispidus LACÉPÈDE, Hist. Nat. Poiss. 1 (1798) pl. 24, fig. 1; RICHARDSON, Voy. Samarang, Fishes 17, pl. 9, figs. 3 and 4; GÜNTHER, Cat. Fishes 8 (1870) 297; DAY, Fishes of India (1878) 706, pl. 183, fig. 2; GÜNTHER, Fische der Südsee 3 (1910) 466, pls. 176 and 177.

Tetradon stellatus EYDOUX and SOULEYET, Voy. Bonite, Poiss. (1841) 212, pl. 10, fig. 2 (not of Lacépède).

Tetradon laterna RICHARDSON, Voy. Sulphur, Zool. (1843) 124, pl. 61, fig. 2.

Crayracion implutus BLEEKER, Atlas Ichth. 5 (1865) 71, pl. 205, fig. 3 (as *Crayracion laterna*).

Dorsal 10; anal 9 or 10. Head 2.3 to 2.6 in length; eyes large, 4 to 5 in head; snout 1.8 to 2.2, interorbital space 2 to 2.3, and depth of caudal peduncle 2.7 to 3.1 in head.

Body short, stout, very thick and rounded forward, tapering to the laterally compressed caudal peduncle; belly capable of very great distension; head broad, with wide blunt snout, upper profile somewhat concave; interorbital space flat or slightly concave; nostrils with bifid tentacles without openings; lips not covering the large, strong, boldly convex teeth. The whole body densely covered with bristly prickles or short slender spines, except on lips, upper part of snout, fin bases, and caudal peduncle; the abdominal spines are stouter and longer, and have two to four roots.

Color in alcohol grayish black, dusky or brown above, very pale to white on the underparts; back, sides, chin, caudal peduncle, and anterior half of caudal fin sprinkled with large circular white spots, those on caudal peduncle much smaller; belly and sides up to base of pectoral marked by longitudinal narrow black stripes which do not extend beyond anal; gill opening margined by a white line, around which is a broad chocolate brown band, this in turn surrounded by a white line; bases of pectorals, dorsal, and anal dark brown; young specimens show dark transverse bars above, one between eyes, one between pectorals, one between pectorals and dorsal, one including dorsal base, and one on caudal peduncle; these bars may be more or less confluent on sides, forming broad vertical dark blotches; some specimens show several broad, elongated, very dark spots or short bars low down on sides; bristles and spines white.

I have examined specimens ranging in length from 31 to 163 millimeters, from the following localities: Culion; Dumaguete,

Oriental Negros; Cabalian, Leyte; Cagayan de Misamis, Caldera Bay, and Zamboanga, Mindanao; Sitanki. It has been recorded previously from Manila, Panay, Cuyo, and Sanguisiapo.

Two large, bulky, and rotund living specimens in the Bureau of Science Aquarium, obtained at Calapan, Mindoro, have the back olive or mouse color, with obscure darker spots, the back, sides, caudal peduncle, and anterior half of caudal fin with many conspicuous white circular spots; the belly is white; the sides below the pectorals and the belly with longitudinal olive or yellowish stripes on one specimen, the stripes lacking on the other; the fins are bright lemon yellow.

The variation in color is very considerable. In life it is more often light olive green above, with pearly or bluish white spots, and with light olive or yellow stripes on the belly.

This easily recognized species is very widely distributed and is common throughout its range, which extends from the Red Sea and the eastern coast of Africa to the Hawaiian Islands, and from the Riu Kiu to the Samoa Islands, Aneiteum, and Panama. This puffer reaches a length of 20 inches, or about 510 millimeters, and is one of the most poisonous members of the group.

Tetraodon mappa Lesson.

Tetraodon mappa LESSON, Voy. Coquille, Poiss. (1826) 102, pl. 5.

Tetrodon mappa GÜNTHER, Cat. Fishes 8 (1870) 293; Fische der Südsee 3 (1910) 464.

Crayracion mappa BLEEKER, Atlas Ichth. 5 (1865) 72, pl. 210, fig. 3 (adult).

Crayracion meleagris BLEEKER, Atlas Ichth. 5 (1865) 72, pl. 210, fig. 1 (young).

Dorsal 11; anal 10. Head equals depth and is contained 2.4 times in length; caudal 0.7 as long as head; snout 1.86, eye 6.6, interorbital space 2.6, and depth of caudal peduncle 3.13 times in head; eye 3.58 times in snout.

The oblong body is much compressed, with slightly convex profile and strongly arched back; the very large head is flattened laterally, with somewhat prominent bony ridges above eyes and broad, nearly flat interorbital space; caudal peduncle comparatively long, not flattened; gill opening large, prominent; the upper teeth project strongly beyond those of the lower jaw; nasal papillæ large, thick, and clumsy in appearance; small but stout white prickles over body except on lips, snout, cheeks, and posterior portion of caudal peduncle; belly distensible, like that of the other tetrodonts.

Color in alcohol brown above, becoming nearly white on belly, and with white lower lip; the entire back and sides covered with elongated wavy and irregular or convoluted very dark brown lines, which pass into circular spots under chin; those on sides of head vertical or radiating from eyes; several large irregular black spots on sides below pectorals; many circular or rounded white spots are scattered over the whole body except on belly, but are most numerous on back, between or inclosed by the lines; all the fins with conspicuous dark brown cross-bars forming a more or less evident network; a wide band of deep chocolate brown around anal opening.

Here described from a specimen 505 millimeters long over all, captured at Calapan, Mindoro; for a long time it was kept alive in the Bureau of Science Aquarium, but it died after some years of captivity. In the University of Santo Tomas Museum is the mounted skin of a specimen from Mindanao, with a length of 435 millimeters, or 535 millimeters including the caudal fin. This specimen is labeled *T. hispidus* but is unquestionably *T. mappa*. There is no other Philippine record of this strongly marked and readily distinguished species. This species was originally described from New Guinea; it is known to occur from Singapore and Java to the Pelew Islands.

Tetraodon aerostaticus (Jenyns).

Tetrodon lineatus BLOCH, Ichtyologie 4 (1787) 127, pl. 161 (not of Linnæus); SCHLEGEL, Fauna Japonica (1847) 287, pl. 125, fig. 2, Nagasaki; DAY, Fishes of India (1878) pl. 180, fig. 3.

Crayracion lineatus BLEEKER, Atlas Ichth. 5 (1865) 70, pl. 206, fig. 1, and pl. 212, fig. 1.

Tetrodon aerostaticus JENYNS, Voy. Beagle (1842) 152.

Tetraodon aerostaticus JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 250.

Dorsal 10; anal 9 or 10. Head contained from 2.24 to 2.34 times in length, eye 2.2 times in snout or 4.2 times in head; snout 1.9 times, interorbital space 2.1 to 2.3 times, and the least depth of caudal peduncle 3.5 times or a little less in head; the greatest breadth of head equal to three-fourths or more of the length of head and the uninflated depth of body about equal to head; caudal fin 3.6 to 4 times in head and body.

The wedge-shaped body is short, very deep, and laterally compressed; the greatest width a little behind eyes and in line with the lower part of the gill openings; belly extremely distensible; interorbital space nearly flat, orbital ridges very slightly

elevated; snout short, concave, the large convex upper teeth strongly projecting; caudal peduncle much compressed laterally; anal fin markedly posterior to dorsal.

Entire body, except lips, fin bases, and caudal peduncle, covered with prominent black spines or bristles, those on belly clubbed, but on the other parts of body sharp pointed. Mouth small with black tongue.

The color of a living specimen, 120 millimeters long, in the Bureau of Science Aquarium, was deep dull black above, the belly paler with broad irregular black bands converging toward throat; caudal with large circular black spots; other fins pale lemon yellow, their basal portion black.

In alcohol the same specimen was whitish below, the black bands much more evident; the region about the mouth paler, with small black spots; anus in a circular black spot.

An alcoholic specimen, 111 millimeters long, has a ground color of bluish gray; above and on sides it is covered with more or less circular black spots, all much smaller than eye, smallest and most crowded along the median dorsal portion, largest on the caudal peduncle and fin; broad black bands on belly, the outer ones converging anteriorly; a black ring around vent; pectorals, dorsal, and anal pale with black bases.

The two specimens here described were taken at Calapan, Mindoro, in March, 1924. A very small specimen, approximately 50 millimeters long, was captured at Legaspi Landing, Manila, August 3, 1924, and added to the living collection at the Bureau of Science Aquarium. This species, which is very distinct from any other tetrodonts of the Philippine fauna, occurs in the East Indies and northward to Japan. It has been confused much of the time with other species from various parts of the world, but probably occurs throughout the warmer parts of the Indian Ocean and eastward at least to Amboina.

Tetraodon nigropunctatus Bloch and Schneider.

Tetraodon nigropunctatus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 507; GÜNTHER, Cat. Fishes **8** (1870) 293; DAY, Fishes of India (1878) 704, pl. 180, fig. 4; GÜNTHER, Fische der Südsee **3** (1910) 468.

Tetraodon nigropunctatus JORDAN and SEALE, Bull. Bur. Fisheries **25** (1905) 369, text fig. 70 and pl. 35; EVERMANN and SEALE, Bull. Bur. Fisheries **26** (1906) 101.

Crayracion nigropunctatus BLEEKER, Atlas Ichth. **5** (1865) 74, pl. 206, fig. 4.

Dorsal 10; anal 10. Head from 2.2 to 2.8 times in length; eye from 4 to nearly 5.5 times, snout 2 to 2.3 times, interorbital space 2.1 to 2.2 times, and caudal peduncle 2.85 to 3.28 times in head.

Body somewhat elongate, subcylindrical, back strongly arched; head pointed, with a blunt, concave snout, and broad, flat, or nearly flat, interorbital space; belly greatly distensible; caudal fin smaller than in some related species, with moderately convex posterior margin, its length about 3 times in that of head and trunk; entire body except lips and posterior part of caudal peduncle covered with white bristles; in some specimens the bristles may be almost entirely hidden in the skin so that most of the body seems to be smooth.

Color in alcohol brown or blackish above, becoming paler, grayish or whitish, on belly; a few large black irregular spots scattered over body, particularly on belly; snout and around mouth black or very dark brown; anus in a black spot; dorsal and anal brown or blackish, the free margin usually pale; caudal brown or blackish, edged with pale, whitish or yellowish, never black.

Here described from four specimens, 84 to 170 millimeters in length, collected at Puerto Galera and Calapan, Mindoro, and Dumaguete, Oriental Negros. It has been recorded previously from Bacon, Sorsogon Province, Luzon. A lemon yellow albino variety is common in some regions, but is thus far not known from the Philippines.

This species which often looks more like a fur-bearing animal than a fish, reaches a length of 260 millimeters and occurs from Zanzibar on the east coast of Africa, and Mauritius in the Indian Ocean, to the Samoan Islands.

Tetraodon fluviatilis Buchanan-Hamilton.

Tetraodon fluviatilis BUCHANAN-HAMILTON, Acct. Fishes River Ganges (1822) 6, 362, pl. 30, fig. 1; GÜNTHER, Cat. Fishes 8 (1870) 299; DAY, Fishes of India (1878) 707, pl. 183, fig. 1.

Tetrodon nigroviridis PROCÉ, Bull. Sci. Soc. Philomat. (1822) 130.

Crayracion fluviatilis BLEEKER, Atlas Ichth. 5 (1865) 68, pl. 210, fig. 4.

Dorsal 12–13; anal 11–12. Head equal to depth and contained 2.1 to 2.3 times in length; snout 2.35 to 2.5 times, eye $4\frac{1}{6}$ to 4.7 times, interorbital space 1.8 to a little more than twice, and depth of caudal peduncle 2.5 to 2.9 times in head; eye

contained $1\frac{2}{3}$ to twice in snout; length of caudal fin contained 3 to 3.3 times in head and trunk together.

The thick, heavy, somewhat ovate body is subcylindrical anteriorly, compressed posteriorly, with large head and broad blunt snout but little narrowed, sides of head compressed; interorbital space convex and very broad; upper profile a continuous arch from tip of snout to origin of caudal fin, highest just posterior to pectoral; mouth wide; caudal fin very broad; belly moderately distensible; small, stout, widely spaced spines over entire body except on snout, chin, and tail.

Color in alcohol brown above, paler on sides, and gray, yellowish, or yellowish white on belly; back and sides more or less thickly sprinkled with large dark brown spots, mostly circular; caudal with many brown crossbars, the other fins clear.

Here described from seven specimens, 32 to 77 millimeters in length, collected by Alvin Seale in 1908 at Sandakan, Borneo; the largest has a length of 102 millimeters over all. This species was described by Procé,[7] from Manila, and a specimen in the British Museum was obtained in the Philippines by Hugh Cuming, who was in the Islands from 1836 to 1840. Apparently, no one has obtained it in the Philippines since that time.

This little poisonous fish attains a length of 158 millimeters, and occurs in the mouths of rivers and along the coasts of the Indies from the Philippines to Hindustan.

CANTHIGASTERIDÆ

A family of small puffers differing from the Tetraodontidæ in having the back more or less compressed or ridgelike and in having a sharp or pointed snout; the nostrils are absent or feebly developed; vertebræ 8+10. Gill gives the skeletal characters as follows: Medifrontals separated from the supraoccipital by the intervention of the sphenotics, which are connected and laterally expanded, but short; the prosethmoid prominent above, enlarged and narrowed forward.

The family contains a single genus with about twenty species of brilliantly colored and beautifully decorated little puffers of tropical or subtropical seas; apparently none is more than 160 millimeters in length.

[7] Loc. cit.

Genus **CANTHIGASTER** Swainson

Canthigaster SWAINSON, Class. Fishes 2 (1839) 194.

The characters of the genus are included above.

Key to the Philippine species of Canthigaster.

a^1. Three or four broad, dark crossbands .... **C. valentini.**
a^2. No broad, dark crossbands.
  b^1. Back and sides with fine, wavy longitudinal bluish lines. **C. compressus.**
  b^2. Back and sides without numerous wavy longitudinal bluish lines.
    c^1. Cheeks, back, sides, and caudal fin with large, bluish, dark-edged ocelli .... **C. papua.**
    c^2. Sides and belly sprinkled with dark blue dots, much more numerous on sides of head .... **C. bennetti.**

Canthigaster valentini (Bleeker).

Tropidichthys valentini BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 130.
Canthogaster valentyni BLEEKER, Atlas Ichth. 5 (1865) 80.
Psilonotus valentyni BLEEKER, Atlas Ichth. 5 (1865) pl. 208, fig. 1.
Tetrodon valentini GÜNTHER, Cat. Fishes 8 (1870) 305; Fische der Südsee 3 (1910) 474, pl. 172, fig. C.
Canthigaster cinctus JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 [1] (1903) 433, fig. 189.

Dorsal 9; anal 9. Depth contained 2.1 times, head 2.75 times, and caudal 3.6 times in length; snout contained 1.3 times in head; eye contained 4.14 times in head, 3 times in snout, and 1.55 times in interorbital space, the last named contained 2.6 times; depth of caudal peduncle a trifle more than twice in head.

Body irregularly oblong, much compressed, with a narrow dorsal ridge, concave interorbital space, sharply pointed head, upper and lower profiles forming a blunt triangle, caudal peduncle wide; dorsal and anal fins small and weak; entire body covered with very short, harsh, rather widely spaced prickles.

There is a broad blackish brown crossband behind eyes and above gill openings; a second and broader one above pectorals, descending over base of pectorals in a narrow bar and extending diagonally backward on to abdomen; a third bar in front of dorsal descends nearly vertically almost to middle of abdomen; behind dorsal a broad saddle on caudal peduncle, extending back as a dark bar on upper margin of caudal fin; blotches of similar color about anus and at base of lower margin of caudal; interspaces spotted with many large orange or brown ocelli

which become smaller ventrally and on head; some brown horizontal lines below and behind eye and extending posteriorly to caudal peduncle; very narrow faint dark lines crossing snout transversely and also longitudinal ones on interorbital space, curving downward in front of eye; some pale transverse bands on breast.

The above description is of a specimen 80 millimeters long, or 102 millimeters over all, from Cabalian, Leyte. An old specimen in the Bureau of Science collection, 33 millimeters long, obtained at Puerto Princesa, Palawan, has the ground color bluish white, the interspaces between the dark brown crossbars appearing as conspicuous white lines.

This beautiful little fish is found from Zanzibar to Samoa and Tahiti, and northward to the Hawaiian Islands, if Günther is correct in placing Jordan and Evermann's *Canthigaster cinctus* in the synonymy of this species, as I believe he is.

Canthigaster compressus (Procé). Plate 2, fig. 5.

Tetrodon compressus PROCÉ, Bull. Sci. Soc. Philomat. (1822) 130.

Canthigaster compressus JORDAN and SEALE, Proc. U. S. Nat. Mus. **28** (1905) 791; Bull. Bur. Fisheries **26** (1906) 37; EVERMANN and SEALE, Bull. Bur. Fisheries **26** (1906) 101; Proc. U. S. Nat. Mus. **31** (1906) 510; SEALE and BEAN, Proc. U. S. Nat. Mus. **33** (1907) 248.

Tetraodon striolatus QUOY and GAIMARD, Voy. Uranie, Zool. (1824) 203.

Canthogaster striolatus BLEEKER, Atlas Ichth. **5** (1865) 82.

Psilonotus striolatus BLEEKER, Atlas Ichth. **5** (1865) pl. 213, fig. 6.

Tetrodon striolatus GÜNTHER, Cat. Fishes **8** (1870) 304; Fische der Südsee **3** (1910) 473.

Dorsal 9; anal 8. Depth contained twice, head 2.27 to 2.42 times, and caudal 2.75 to 3 times in length; snout 1.5 times or a trifle less in head; eye 3.6 to 3.8 times in head, 2.4 to 2.6 times in snout, and 1.4 to 1.6 times in interorbital, which is $2\frac{3}{8}$ to 2.5 times in head; depth of caudal peduncle 2.1 to 2.25 in head.

Body irregularly oblong, strongly compressed laterally, with pointed head and elongate, slightly concave snout and broad caudal peduncle; a narrow dorsal ridge extends from a point above gill openings to dorsal; interorbital space concave; very small, widely spaced spinules on head and trunk, but absent behind origin of dorsal and anal.

Color in alcohol yellowish brown, dark dorsally and pale ventrally, with fine wavy longitudinal bluish lines along back and sides; broader transverse blue lines between eyes, crossing snout, and continued backward along upper half of head; below these

are small rounded or irregular bluish spots; a large dark ocellus with a blue margin on each side below base of dorsal; caudal yellowish, cross-barred with vertical bluish lines; the other fins all pale yellowish.

Here described from two small specimens 41 and 46 millimeters long, collected at Bantayan Island. Another specimen, 44 millimeters long, in the Bureau of Science collection, came from Sorsogon Province, Luzon. This species was originally described from Manila and occurs commonly about Celebes and the Spice Islands and eastward to Faté, one of the New Hebrides.

Canthigaster papua (Bleeker).

Tetraodon papua BLEEKER, Journ. Ind. Arch. 2 (1848) 638.

Tetrodon papua GÜNTHER, Cat. Fishes 8 (1870) 301; Fische der Südsee 3 (1910) 471.

Canthogaster margaritatus BLEEKER, Atlas Ichth. 5 (1865) 82.

Psilonotus margaritatus BLEEKER, Atlas Ichth. 5 (1865) pl. 213, fig. 4.

Tropidichthys papua WEBER, Fische der Siboga Exp. (1913) 587.

Dorsal 9; anal 9. Depth 1.9, head 2.5, and caudal 3.38 times in length; snout 1.5 times, interorbital $1\frac{2}{3}$ times, and depth of caudal peduncle 1.7 times in head; eye 4 times in head, $2\frac{2}{3}$ in snout, and 1.5 in interorbital.

Body roughly oblong, rather thick but compressed laterally, with the portion behind dorsal and anal very wide and strong; head bluntly pointed, with concave snout and broad, very slightly concave interorbital space; the portion behind dorsal and anal smooth, the rest of trunk and head covered with small, feebly developed prickles.

Color in alcohol brown, paler on belly, with many large dark-edged ocelli scattered over cheeks, back, sides, and caudal fin; a large dark spot on each side at base of dorsal fin, encircled anteriorly by an incomplete bluish line which passes backward along top of caudal peduncle instead of curving upward to complete the circle; transverse dark brown lines across interocular space and snout and curving downward and backward on cheeks; some dark lines radiating posteriorly from eyes; a dark brown median line on belly from chin to anus.

Here described from a specimen 61 millimeters long, obtained at Dumaguete, Oriental Negros, by the zoölogical department of Silliman Institute.

I place here a specimen, 57 millimeters long, collected at Guam by R. C. McGregor. In this specimen the large bluish

ocelli are very well marked, though their darker margin is not so clearly defined. The snout is more pointed and the color much paler than in the Dumaguete specimen. The line on the belly has almost disappeared. The Bureau of Science collection also contains a specimen, 46 millimeters long, from Bantayan. Weber collected a specimen 13 millimeters long in surface plankton at North Ubian, an island of the Sulu Archipelago.

This very handsome little puffer occurs in the East Indies and in the Pacific to the Mariana Islands and the Bismarck Archipelago. Bleeker's *C. margaritatus* is not *Tetrodon margaritatus* of Rüppell.

Canthigaster bennetti (Bleeker).

Tetrodon ocellatus BENNETT, Fishes Ceylon (1834) 21, pl. 21 (not of Bloch).

Tropidichthys bennetti BLEEKER, Nat. Tijdschr. Ned. Ind. 6 (1854) 504; WEBER, Fische der Siboga Exp. (1913) 586.

Canthogaster ocellatus BLEEKER, Atlas Ichth. 5 (1865) 80.

Psilonotus ocellatus BLEEKER, Atlas Ichth. 5 (1865) pl. 214, fig. 5.

Tetrodon bennetti GÜNTHER, Cat. Fishes 8 (1870) 301; Fische der Südsee 3 (1910) 471.

Canthigaster bennetti EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 101.

Dorsal 9; anal 8. Depth contained 2.46, head 2.875 times in length; snout contained 1.5 times in head; eye contained 4.8 times in head, 3.2 times in snout, and 1.6 times in interorbital space which is contained 3 times in head and twice in snout; caudal peduncle contained 2.18 times in head.

Body elongate oblong, laterally compressed but rather thick and somewhat rounded posteriorly, head deep and narrow with long and pointed snout; upper profile straight, interorbital space slightly concave; very fine prickles over body except behind anus and posterior portion of caudal peduncle.

An alcoholic specimen 69 millimeters long, collected at Cabalian, Leyte, is colored as follows: The dorsal half is dark, with brown and bluish black irregular spots and bands, forming angles behind dorsal with the points of the angles directed backwards; lower half of sides and belly pale, whitish; sides and belly sprinkled with small dark blue circular dots intermingled with white circular spots; these spots are most numerous on sides of head; on tail and in lower portion of dark part of sides the blue dots are widely separated and ocellated, with a broad white ring; several dark blue horizontal lines crossing eye and continuing forward on snout, the lower ones alternating

with white lines; three short, dark blue, white-margined vertical bands on each side of snout behind mouth; a large dark spot with an incomplete blue or bluish marginal line about it on base of dorsal; a bluish line from behind chin along median line of throat and forward part of belly; the rays of the pectorals dusky, the rest of the fins clear.

I have also examined four small specimens from 35 to 50 millimeters in length, collected at Bacon, Sorsogon Province, Luzon; Caldera Bay, Mindanao; and Sitanki. These agree in all essentials with the one described, except that the color is more brown above and yellowish brown on the lower half of body, while the snout in some is slightly convex. This beautiful little puffer reaches a length of about 100 millimeters and occurs from Zanzibar, on the east coast of Africa, to Ponapé in the Caroline Islands and to Tahiti in the South Seas. It has been previously recorded from the Philippines from Bacon, Sorsogon Province, Luzon, and from North Ubian, one of the islands of the Sulu Archipelago.

DIODONTIDÆ

PORCUPINE FISHES; BOTITING LAOT

The stout broad body is almost flat above and the head end is nearly square in living, uninflated specimens; the belly is moderately to greatly distensible, everywhere covered with spines except on the lips and caudal peduncle; the hard stiff spines have a bony base and may be two-rooted and erectile or three-rooted and immovable; the mouth is of medium size, terminal, each jaw covered by an entire bony beaklike plate, without joints; the nostrils on each side form a small tentacle, usually with two openings; the eyes are large, often protruding; the gill opening is of medium size, immediately in front of the pectoral, which is short, rounded, and very wide; the dorsal and anal fins are far back, nearly alike in size and shape, and nearly opposite each other.

These fishes of warm seas are widespread in the Tropics, where they are common about coral reefs, while their singular form and armor have caused them to be carried to all parts of the world as curios. Like the puffers they swallow air until they are nearly helpless and become more or less globose and porcupine-like, floating belly up at the surface.

The fishes of this family have a well-deserved reputation for being poisonous, and their flesh should never be eaten.

Of the half dozen genera known, two occur in the Philippines.

Key to the Philippine genera of Diodontidæ.

a^1. Dermal ossifications all or nearly all with two roots, the spines long and erectile .... **Diodon.**

a^2. Dermal ossifications all or nearly all with three roots, the spines short, stout, immovable.......... **Chilomycterus.**

Genus **DIODON** Linnæus

Diodon LINNÆUS, Syst. Nat. ed. 10, 1 (1758) 335.

Body robust, head and anterior part squarish; the stout, stiff, and very sharp spines mostly two-rooted and erectile; a few only are three-rooted and therefore immovable; the simple nasal tube has two lateral openings.

The species of this readily recognized genus are few in number, but are very widely distributed in the tropical and warm temperate portions of the ocean.

Key to the Philippine species of Diodon.

a^1. Entire body or all except belly with numerous small circular dark spots .... **D. hystrix.**

a^2. Body not spotted as above.

b^1. Thirteen to sixteen spines from snout to dorsal, eighteen to twenty across belly between pectorals; orbital spines equal to or much longer than eye.......... **D. holacanthus.**

b^2. Eighteen to twenty spines from snout to dorsal, twenty-six to twenty-eight across belly between pectorals; orbital spines much less than eye diameter.......... **D. bleekeri.**

Diodon hystrix Linnæus.

Diodon hystrix LINNÆUS, Syst. Nat. ed. 10, 1 (1758) 335; GÜNTHER, Cat. Fishes **8** (1870) 306; DAY, Fishes of India (1878) 708, pl. 179, fig. 4; JORDAN and EVERMANN, Fishes N. and M. America **2**, U. S. Nat. Mus. Bull. **47** (1898) 1746, pl. 266, fig. 648; Bull. U. S. Fish Comm. **23**[1] (1903) 437, fig. 192; GÜNTHER, Fische der Südsee **3** (1910) 474.

Diodon atinga BLOCH, Ichtyologie **4** (1787) 75, pl. 125.

Paradiodon hystrix BLEEKER, Atlas Ichth. **5** (1865) 56, pl. 207, fig. 2.

Diodon punctatus PETERS, Monatsber. Akad. Wiss. Berlin (1868) 276.

Dorsal 13; anal 12. Head contained 2.5 times, caudal 4.2 times in length; eyes large, 3.8 times in head and 1.6 times in snout, which is $2\frac{1}{3}$ times in head; interorbital flat, very broad, 1.4 times in head; depth of caudal peduncle about the same as eye diameter.

Body thick, heavy, somewhat elongate, very broad anteriorly, tapering posteriorly, with rather rounded caudal peduncle, snout very short, very slightly concave, mouth wide, the lower dental plates rounded, the upper hardly convex, with roughened margin

at center; spines long, stout, with broad base, over entire body except snout and sides of tail, those behind pectorals largest; those on posterior part of back short and at least some of them three-rooted; two or three pairs of nonerectile spines on top of caudal peduncle between dorsal and anal fins and also on its ventral surface.

Color in alcohol brownish gray, darker above and nearly white on belly; upper part of head and trunk and sides and fins thickly sprinkled with rather small circular or rounded dark spots, smallest and most numerous anteriorly, larger and farther apart on caudal peduncle; a brown band passes under chin from eye to eye and is curved forward behind chin. The spots are brown but according to authors may be blue.

Here described from a specimen 210 millimeters long, collected at Sitanki. There is a very large specimen in the Ateneo de Manila Museum, obtained at Cavite, which is 470 millimeters long, with a total length of 570 millimeters, and with two dark brown transverse bars on dorsal and caudal fins; and another specimen, 240 millimeters long, from Surigao, Mindanao. In the University of Santo Tomas Museum is a small specimen from Manila Bay. Specimens of this species were collected by Jagor at Paracale, Camarines Norte, Luzon. It occurs in the tropical Pacific, Indian, and Atlantic Oceans, and is found in many curio collections.

Diodon holacanthus Linnæus.

Diodon holocanthus LINNÆUS, Syst. Nat. ed. 10, 1 (1758) 335 (based on Artedi; misprint for *holacanthus*); JORDAN and EVERMANN, Fishes N. & M. America 2, U. S. Nat. Mus. Bull. 47 (1898) 1746; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 257; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23[1] (1903) 436.

Diodon quadrimaculatus, sexmaculatus, novemmaculatus, multimaculatus CUVIER, Mém. Mus. Hist. Nat. 4 (1818) 136–138, with figures, pls. 6 and 7.

Diodon novemmaculatus SCHLEGEL, Fauna Japonica, Poiss. (1847) 289, pl. 128, fig. 2.

Paradiodon quadrimaculatus BLEEKER, Atlas Ichth. 5 (1865) 58, pl. 212, fig. 2.

Diodon maculatus GÜNTHER, Cat. Fishes 8 (1870) 307; Fische der Südsee 3 (1910) 475.

Dorsal 12; anal 12. Head contained 2.25 times, caudal fin $5\frac{1}{11}$ times in length; the large prominent eyes 3.57 times in head and nearly equal to snout, which is $3\frac{1}{8}$ times in head; the wide and nearly flat interorbital $1\frac{5}{8}$ times, depth of caudal peduncle $8\frac{1}{3}$ times in head.

Body wedge-shaped, very broad and stout anteriorly, with flattened dorsal and ventral surfaces, or back gently rounded; snout straight or nearly so, jaws rounded, the upper hardly convex; entire body except lips covered with long spines, all two-rooted and erectile except those on hind part of body, which may be three-rooted; three or four spines at least an eye diameter in length above each eye and two long spines between anterior pair; frontal spines longer than those behind pectorals; fourteen rows of spines between snout and dorsal fin in my specimen; thirteen to sixteen rows according to Günther; there are eighteen to twenty rows of spines across belly between the pectorals.

Color in life brownish gray above, nearly white beneath, with a series of broad velvety brown transverse bands and spots; the first is on interorbital space from eye to eye and downward on side as a pointed stripe to undersurface; midway between this and pectorals is another wide crossbar; on sides behind and above pectorals is a crescent-shaped spot; farther behind on middle of back is another spot; a similar spot about base of dorsal; small rounded or elongate blackish spots scattered over whole body; the protuberant eyes greenish; fins colorless.

Color in alcohol pale brown above, shading off to creamy white on belly; the markings as above indicated, the colors duller.

Here described from an alcoholic specimen, 56 millimeters long, collected at Jolo, and two much larger living ones, obtained at Calapan, Mindoro, the larger one of these about 180 millimeters in length. In the Ateneo de Manila Museum is a specimen from Cavite. It was recorded by Günther from the "Sooloo Sea."

A specimen from Mindoro in the University of Santo Tomas Museum, labeled *D. spinissimus*, probably belongs here. It is 215 millimeters long and has exceedingly long spines above, between, and forward of the eyes, twice or more than twice the diameter of an eye.

This species occurs in all warm waters of the Pacific, Indian, and Atlantic Oceans.

Diodon bleekeri Günther.

Paradiodon novemmaculatus BLEEKER, Atlas Ichth. 5 (1865) 57, pl. 206, fig. 3 (not of Cuvier).

Diodon maculatus var. β GÜNTHER, Cat. Fishes 8 (1870) 308.

Diodon bleekeri GÜNTHER, Fische der Südsee 3 (1910) 475, pl. 178.

Dorsal 14; anal 14. Orbital spines much shorter than diameter of eye, the longest about 0.72 of eye; spines behind pectorals longest, some of them equaling eye; apparently all the spines are two-rooted and erectile; no spines or bony plates on caudal peduncle behind dorsal and anal, the two spines lying along its side anteriorly having their roots opposite dorsal; eighteen or twenty spines in a row between snout and dorsal; twenty-six to twenty-eight in a row from pectoral to pectoral across belly; length of pectoral fin less than half its breadth; belly capable of great distension.

Color in alcohol brown above, becoming yellow on belly, with a small dark brown spot behind each spine on sides behind pectorals; remainder of body and fins unspotted; nine large, blackish brown, white-margined spots or crossbars on upper parts as follows: The first across each eye and downward as a broad bar toward belly; the second across top of head, nearer pectorals than eyes; a short bar in front of each gill opening; a large nearly circular spot above and behind each pectoral; a still larger, nearly circular spot on middle of back; the last dark area surrounds base of dorsal fin.

Here described from a specimen, 275 millimeters long, obtained at Manila.

This species reaches a length of 360 millimeters and occurs in the East Indies from Sumatra and Singapore to New Guinea, and southeastward in the Pacific to the Society Islands.

Genus **CHILOMYCTERUS** Bibron

BURFISHES; RABBIT FISHES

Chilomycterus BIBRON in Barneville, Rev. Zool. (1846) 140.

The broad, flattened body is much like that of *Diodon;* the spines are very much shorter and stouter, stiff, erect, immovable, somewhat triangular, all or nearly all with three roots each, their expanded bases forming a coat of mail; the simple nasal tube has two lateral openings; the tube is sometimes rounded and sometimes flattened, with a weak and easily torn partition so that it may appear divided; the caudal peduncle is rather short.

The species are usually smaller than those of *Diodon;* one is known from the Philippines.

Chilomycterus orbicularis (Bloch).

Diodon orbicularis BLOCH, Ichtyologie 4 (1787) 81, pl. 127; BLEEKER, Atlas Ichth. 5 (1865) 55, pl. 205, fig. 4.

Chilomycterus orbicularis GÜNTHER, Cat. Fishes 8 (1870) 312; Report Voy. Challenger, Zool. 1 (1880) Report on Shore Fishes, 54.

Diodon caeruleus QUOY and GAIMARD, Voy. Uranie, Zool. (1824) 201, pl. 65, fig. 5 (young).

Head 2.25 times, caudal fin 3.8 times in length; the large protuberant eyes about 3.25 times in head and nearly equal to snout, which is a third as long as head; interorbital space $2\frac{1}{3}$ times in head; caudal peduncle small and weak, its depth 7 times in head.

The spines are all three-rooted, short, sharp, and very strong, with low, widespreading roots; a row of three spines above each eye, their bases forming a ridge convergent toward front; a single spine in middle of forehead midway between anterior ends of orbital ridges; eight or nine rows of spines between snout and dorsal fin; tail spineless, but the roots of a single pair of spines extend across behind dorsal fin; mouth rather wide, horizontal, lower jaw rounded, upper one obtusely pointed. This fish can distend itself until it is nearly globular.

Color brown above, marbled with darker bands, whitish on belly; fins brown, more or less transversely banded with darker.

Here described from a curiously deformed specimen, 95 millimeters long, collected at Manila in 1911 by Alvin Seale. Specimens of this species were taken by the *Challenger* off the coast of Cebu at a depth of 18 fathoms. In the collection of the Ateneo de Manila is a dried specimen from Cavite, Manila Bay, and one 245 millimeters long from Tandag, Surigao Province, Mindanao. In the University of Santo Tomas Museum are two specimens from Mindoro and one from Batangas, the larger one about 305 millimeters in length.

This species is apparently confined to the East Indies and the Indian Ocean.

MOLIDÆ

HEADFISHES

These singular and preposterous-looking fishes of the open sea are apparently nothing but an enormous head, or the anterior third of a large fish, with a little frill behind and a long knifelike fin protruding at right angles to the body above and below, just forward of the frill-like caudal. Two genera are known, *Mola* and *Ranzania*. The first named contains but a single species, nearly circular, and attaining a diameter of 8 feet (about 2.5

meters) or more. *Mola mola* (Linnæus), the sunfish or headfish of the open sea, has thus far not been reported from the Philippines, though unquestionably it must occur along the eastern shores of the Archipelago from time to time. It is a poor swimmer, as far as known, and is carried by ocean currents over all temperate and tropical seas. The other genus has been collected in Philippine waters.

The body is oblong or short and deep, compressed, truncate behind, so that the fish appears bitten off. The skin is rough and naked, spinous, or tessellated. The mouth is terminal and very small; the teeth in each jaw are completely united, forming a bony beak without a median suture, as in the Diodontidæ. The dorsal and anal fins are very much alike, falcate, and may be more or less confluent with the caudal; there is no spinous dorsal and no ventral fins are present; the pectorals are behind the small gill openings; there is an accessory opercular gill; there is no air bladder and the belly cannot be inflated.

The very young are spinous and very much shortened in form. The flesh of the headfish is coarse, tough, and of doubtful edibility; that of *Ranzania* is said to be good.

Genus **RANZANIA** Nardo

Ranzania NARDO, Ann. Soc. Regn. Lombard. Venet. 5 (1840) 10, 105.

Body greatly compressed, oblong, depth $\frac{4}{7}$ to a trifle more than 0.5 of length; skin smooth, tessellated, divided into small hexagonal scutellæ; caudal truncate; dorsal and anal long, narrow, falcate. Strange fishes of the open sea, looking like the anterior third of a fish, with a frill added for a tail; apparently they do not grow to much more than 600 millimeters in length. Two species are known, one from the Mediterranean and the Atlantic Ocean about Madeira; and the other, which may not be distinct, known from six examples in the Pacific Ocean.

Ranzania makua Jenkins.

Ranzania makua JENKINS, Proc. Calif. Acad. Sci. II 5 (1895) 780, 784, with plate; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 262; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 [1] (1903) 440, fig. 194.

Dorsal 17; anal 18. Depth 1.75 times, head 2.5 times, and caudal fin $11\frac{2}{3}$ times in length; eye 7 times in head and 2.5 times in snout, which is $\frac{1}{7}$ of the length and is 2.8 times in head.

Body greatly compressed and of strange appearance, being apparently but the head of a large fish; dorsal margin gently

convex anteriorly, then low and nearly straight; ventral margin a convex, evenly curved keel; dorsal and anal fins elongate, narrow, dorsal fin erect, anal slanted obliquely backward; eye above axis of body and above mouth.

The color is uniform silver, without trace of the beautiful life colors and bands shown in the handsome plate accompanying Jenkins's description.

Here described from a stuffed specimen in the Ateneo de Manila Museum. This specimen, which came from Samar, has the following dimensions: Length, 350 millimeters (including caudal, 380) ; depth, 200; distance from tip of dorsal to tip of anal, 330; head, 140; snout, 50; eye, 20.

This rare fish, which attains a length of half a meter, is known only from four examples from Hawaii, the type locality, and a Japanese painting made about 1850, representing a specimen caught "off the Sea of Akabane in Mikawa." Unlike other gymnodonts, this fish swims with almost incredible rapidity.

Günther unites this species with *Ranzania truncata* Nardo, of the Atlantic Ocean, from which it is only doubtfully distinct. Whether he is correct or not in doing so can only be settled by a comparison of ample material.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Balistapus undulatus* (Park).
2. *Odonus niger* (Rüppell).
3. *Monacanthus chinensis* (Bloch).
4. *Stephanolepis tomentosus* (Linnæus).

PLATE 2

FIG. 1. *Cantherines macrurus* (Bleeker).
2. *Cantherines sandwichiensis* (Quoy and Gaimard).
3. *Oxymonacanthus longirostris* (Bloch and Schneider).
4. *Spheroides lunaris* (Bloch and Schneider).
5. *Canthigaster compressus* (Procé).

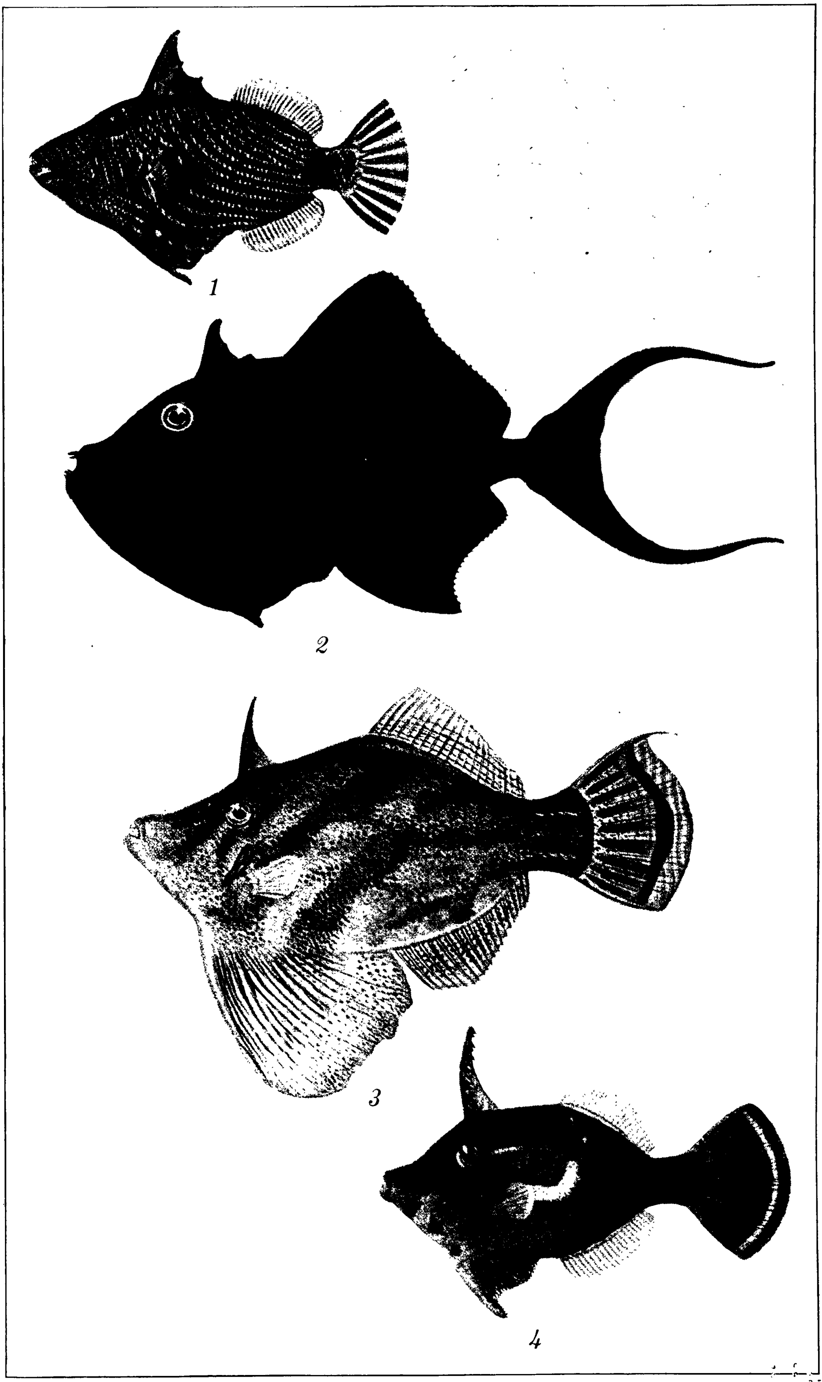


PLATE 1.

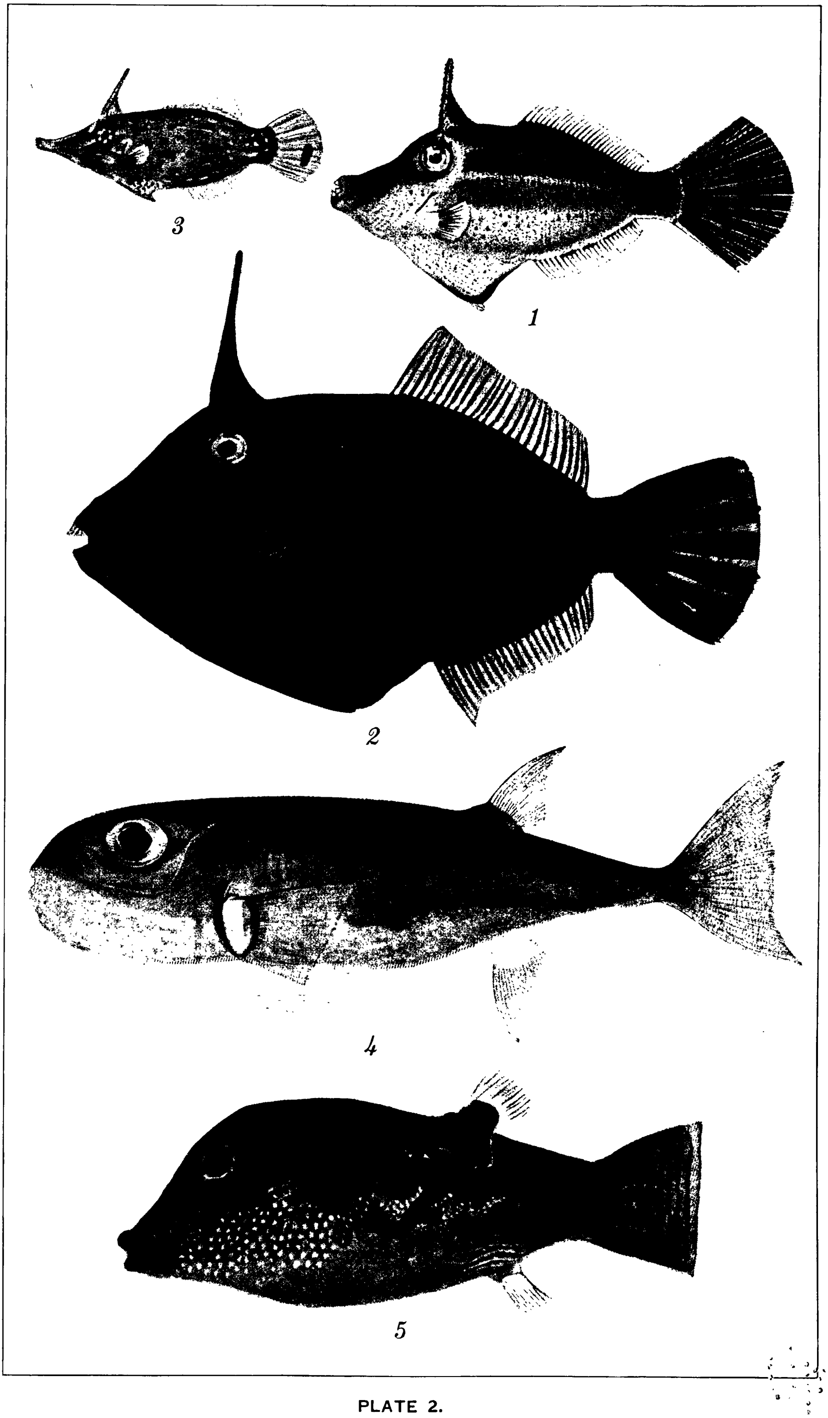


PLATE 2.

SOME DEPARTURES FROM THE TYPICAL CELL PICTURE OF BACILLARY AND AMŒBIC DYSENTERY WITH SPECULATIONS AS TO THEIR SIGNIFICANCE, I

OBSERVATIONS ON SOME POST-BACILLARY EXUDATES, AND ON THE PRESENCE OF EOSINOPHILES IN INTESTINAL ALLERGY

By FRANK G. HAUGHWOUT
Of the Bureau of Science, Manila

EIGHT PLATES

When Willmore and Shearman (7) published their paper on the differential diagnosis of the dysenteries by the microscopic examination of the bowel exudate, they placed before such physicians and microscopists as have familiarized themselves with it a system of procedure that most certainly has reduced the mortality from these disorders in a very substantial degree. Though not spectacular in the sense that cholera, smallpox, leprosy, and yaws are spectacular, dysentery is, none the less, a steady drain on the population of every community in the Tropics, and is not by any means a negligible factor in the public-health problem in certain communities lying in temperate climates.

Summed up, Willmore and Shearman accomplished two vitally important things; they described a method by which it becomes possible to institute specific treatment against bacillary dysentery within two or three hours of its onset—a desideratum most important to the successful management of this condition; secondly, they established the sharp distinction between the exudate produced by *Bacillus dysenteriæ* and that accompanying the uncomplicated activities of *Entamœba histolytica*, showing that a heavy leucocytic exudate is not a feature of simple amœbic dysentery.

The fundamental principles established by Willmore and Shearman have been confirmed since, and additions to our knowledge bearing on the significance of bowel exudates have been made by Bahr and Willmore, (2) Anderson, (1) Haughwout, (3, 4, 5, 6) and others. This paper is one of a series in which I

shall record the results of my own observations in the study of dysenteric and other intestinal exudates I hope to show, by these observations, that the applicability of the method extends beyond the limits set by Willmore and Shearman—that is to say, the differential diagnosis of acute dysentery—and that careful study of these exudates often yields information of the greatest importance in connection with the clinical management of a number of acute to subacute conditions in the lower intestinal tract. It is my intention in this particular paper, to record some observations I have made in certain post-dysenteric cases, with the aim to emphasize the vital importance of continuing the microscopic study, through convalescence and for a while subsequent thereto, of the fæces of patients who have suffered from bacillary dysentery. This is a procedure that frequently is carried out after amœbic dysentery to determine if the subject has been cleared of his infection, but it is not ordinarily followed after bacillary dysentery. I also shall offer a few remarks on the presence of eosinophile cells in bowel discharges.

Proceeding to the first topic, the microscopic study of the fæces of post-bacillary subjects, we have to deal with two rather distinct cell pictures; first, that presented by the more or less regressive cytological changes that include the progressive decline in numbers of endothelial macrophages and the subsidence of cellular evidence of toxic necrosis in cells of all types; this picture gradually shades into the second cell picture, that is the expression of a residual purulent process in unhealed areas in the colon and in which *Bacillus dysenteriæ* probably plays little, if any, part. In the latter stage, annular degeneration of leucocyte nuclei usually becomes less marked and the nuclei tend to regain their normal lobed and homogeneous appearance. This stage, in some instances, is succeeded by a desquamative process in the colon in which large numbers of columnar epithelial cells in various stages of degeneration are cast off and form a very distinctive exudate. These epithelial cells frequently form the major portion of the exudate, leucocytes being scarce or totally lacking. I shall speculate on the significance of these appearances, but in full realization that much work remains to be done before the meaning of them will be made clear. However, of themselves, these exudates should afford the clinical man engaged in the treatment of dysentery much food for reflection even if, for the time being, they lead him to nothing better than empirical treatment.

I am frank to say that I am no great believer in chronic bacillary dysentery as a condition of frequent occurrence. That pathologic processes caused by *Bacillus dysenteriæ* occasionally do run a chronic course is not improbable. However, it is my belief that careful study of the intestinal exudate affords us the best proof we have at present that most of the chronic processes following acute bacillary dysentery are caused by organisms or conditions bearing no existing relation to the activities of the dysentery bacillus. In my judgment, these conditions should be appraised and treated on the basis of the rather definite evidence that most of them afford and which can readily be secured through the intelligent use of the microscope.

As has been said, treated cases of amœbic dysentery usually are followed microscopically for a period of time, in order to discover if the patient resumes the passage of cysts of *Entamœba histolytica* which, if found, serve as the indication for the repetition of treatment. However, the search for cysts seldom is accompanied by an equally thorough search for cellular detritus, such as stray polymorphonuclear leucocytes or epithelial cells. Post-amœbic cases, in my experience, occasionally yield evidence of residual ulceration of a mild degree long after it has become impossible to demonstrate cysts in the fæces. When cellular detritus of this kind is found in post-amœbic cases it should receive attention aside from that given to the chronic amœbic condition.

On the other hand, such procedure seldom or never is followed after recovery from the acute symptoms of bacillary dysentery. The almost spectacular response of patients to antidysenteric serum in the milder manifestations of dysentery of the "Flexner type" is, to my mind, responsible for a false sense of security on the part of clinical men, although in justice it must be said that the criteria on which the truth is based rest on microscopic study of the fæces. Under serum, and not infrequently without specific treatment, the bowel movements will lose their mucopurulent character and become formed and fæculent by the third day. This condition usually is the signal for a cessation of serum treatment, especially as the constitutional reaction subsides coincidentally. In consequence, the case is regarded as clinically cured and the patient, who has been on short rations meanwhile, returns to his customary gastronomic routine with enthusiasm. It thereupon devolves upon the

microscopist to furnish the evidence that will lead the clinician to measures designed to ward off permanent damage to the patient's colon. I shall illustrate this specifically below, but at this place I would remark that a not inconsiderable number of these patients yield evidence that an active dysenteric process is still in progress. Inspection of the formed fæcal masses in these cases will show an investiture of mucus, and microscopic study of this often will disclose a heavy leucocytic exudate containing endothelial macrophages and other cellular evidence of an acute bacillary process. It is problematical how much benefit may be expected from the administration of antidysenteric serum at this stage, or even if it is necessary to give it; that is a nut for the clinicians to crack. The fact remains that the evidence indicates that the dysentery bacillus is still at work, and it is cases such as these that swell the roll of those who develop chronic ulcerative conditions of the colon which, if allowed to go on unchecked, lead to permanent pathologic changes in the large intestine.

As a prelude to the consideration of specific cases in point, it seems opportune briefly to review the cytology of the exudates occurring in acute bacillary and acute amœbic dysentery. To this end the reader is referred to Plates 1 and 2, which show fields from the commoner types of bacillary and amœbic exudates, respectively.

The salient features upon which rests the cytodiagnosis of bacillary dysentery are the presence in the bowel exudate of:

1. A massive content of polymorphonuclear neutrophile leucocytes, amounting to about 90 per cent of the total cell content.

2. The presence in varying proportions (about 2 to 10 per cent) of endothelial macrophage cells varying from 15 μ to 20 μ in diameter, many of which will be seen to have phagocytosed erythrocytes.

3. Evidence, in the various cells composing the exudate, of an extreme necrotic process consequent upon a bacterial invasion of great toxicity. This is evidenced by a uniform and simultaneous destruction extending to all parts of the cell. In extreme cases only the cell membrane and a slight residuum of former protoplasmic substance remain, such constituting the so-called "ghost cells" which, with the macrophages, are diagnostic of bacillary dysentery. The exudate of bacillary dysentery is the only product of the bowel that yields this cellular picture. Cells of other types, such as epithelial cells, plasma cells, and leuco-

cytes of various kinds, occur in small and varying proportions; but, for the purposes of diagnosis, they may be disregarded in the presence of the picture I have outlined.

The most striking variation one sees in the general run of exudates of bacillary dysentery lies in the proportion that the endothelial macrophages bear to the remainder of the exudate. In some instances they are relatively few in number, although one scarcely ever encounters a low-power field in which at least two or three cannot be discovered. Such an exudate is shown in Plate 1, fig. 1. In other instances, the macrophages are much more conspicuous, often tending to collect in more or less segregated masses, as shown in Plate 1, fig. 2. The exudates from which these preparations were made were taken from separate cases, each of which yielded a growth of *Bacillus dysenteriæ* (Flexner type) on bacteriological media. I have not been able to correlate these variations with any corresponding variation in clinical symptomatology.

The one salient feature of the exudate of amœbic dysentery is the presence of tissue-dwelling (trophozoite) forms of *Entamœba histolytica.* Amœbic exudates are mucoid or mucofæculent and contain small numbers of polymorphonuclear leucocytes, lymphocytes, and epithelial and plasma cells. Quantitatively, the exudate of uncomplicated amœbic dysentery is very scant, as may be seen on inspection of the two figures composing Plate 2. Endothelial macrophages do not enter into its composition. Nearly all the cells show pathological changes, probably largely due to the action of the untoward environment in which they find themselves. Some may always be found, however, that show a type of degeneration that is characteristic of protozoal dysentery. This seems to be a proteolytic process initiated by the organisms in their customary nutritive activities. Destruction of the cell commences at the periphery, the nucleus remaining intact until practically the entire cytoplasm has been destroyed. These little masses of chromatin occur abundantly in the stools of amœbic and balantidial dysentery and they are called "pyknotic bodies."

As with bacillary dysentery, there are two general types of amœbic exudate. One, illustrated in Plate 2, fig. 1, that is almost devoid of cellular elements aside from the amœbæ, pyknotic bodies, and scattering mononuclear cells of various types, is the so-called simple amœbic exudate. It usually is seen in first attacks of amœbic dysentery and signifies that there is very little secondary bacterial infection of amœbic ulcers.

The second type of amœbic exudate is illustrated in Plate 2, fig. 2. It is the characteristic stool of chronic amœbic dysentery (usually fæculent) and, as will be seen on inspection of the figure, carries on its face the evidence of secondary bacterial infection of amœbic ulcers in the form of somewhat numerous polymorphonuclear leucocytes. Study of these leucocytes will show that virtually they are intact. The nuclei have not undergone the annular degeneration characteristic, in an exaggerated degree, of bacillary dysentery, though it is not by any means restricted to that condition; the cytoplasm is not necrotic and, in many of them, there is no indication of the proteolytic digestion characteristic of amœbic dysentery. In short, these leucocytes are the product of neither bacillary nor amœbic dysentery but, on the contrary, bear evidence of being the expression of a low-grade bacterial invasion of the amœbic ulcers. The preparation was made from material taken from an old and intractable amœbic infection. The patient maintained an almost constant leucocytosis of 12,000 to 14,000 during the period I had the case under observation. Repeated efforts were made to secure a growth of *Bacillus dysenteriæ* from each of these cases, but in no instance was the effort successful.

Having outlined the characters of the four principal types of dysenteric exudate, I shall now proceed to a discussion of some of the variations from these pictures that one encounters, and the significance that, in my judgment, should be attached to them. To do this I shall cite specific cases that were referred to me for study of conditions, the nature of which could not be determined clinically. I might say at this time, that the first four patients (cases B, R, T, and P) all suffered from bacillary dysentery of a mild type. In no instance was there any hyperpyrexia, and the constitutional symptoms were relatively mild. Moreover, none of these patients received antidysenteric serum. In every case the acute symptoms rapidly subsided and within a few days each patient had resumed his, or her, normal activities. These cases are similar to scores that I have studied in the past few years, and I cite them principally to show how completely dependent the clinical man is upon the microscopist for information as to the progress his patient is making, for in no instance did the physical reactions of the patient give any definite clue to the pathologic process that was perfectly apparent on microscopic study of the bowel discharges.

CASE B

Young American male. He had been on a business trip to Mindanao and on the day of his departure for Manila was attacked with abdominal cramps accompanied by purging. His evacuations quickly became mucoid and blood-streaked and he had some fever—how much, he did not know. He boarded the boat for Manila. On the trip north he improved somewhat, but was still sick when he arrived in Manila on the morning of the fifth day after onset. The patient immediately went to his family physician who referred him to me for diagnosis. The bowel discharges at this time, though markedly fæculent, still contained masses of blood-streaked mucus. Examination of this showed the presence of the characteristic cellular exudate of bacillary dysentery. However, the picture indicated a subsidence of the toxic process. In view of this and the fact that the constitutional symptoms had abated, the physician determined not to administer serum. The patient was thereupon placed on a bland diet and colonic irrigations.

The following day (the sixth day after onset) the patient visited me again, bringing with him a specimen of his stool. This was a hard, formed, normal-looking fæcal mass, the external surface of which was invested with a glistening coat of brownish mucus. Examined under the microscope this was seen to contain numerous endothelial macrophages, polymorphonuclear leucocytes, erythrocytes, plasma cells, "epithelioid" cells, as well as considerable fæcal débris and bacteria. There also was a rich infestation with *Blastocystis hominis*. Most of the cells were in fairly good condition, signifying a cessation of the toxic process. A field from the stained exudate of this day is shown as Plate 3, fig. 1. The features enumerated above will be recognized in the figure as well as the fairly intact condition of cells and their nuclei.

The patient at this time complained of dull abdominal pain. His bowel movements averaged about two per diem and were formed to a degree bordering on constipation. Mucus always was present on the external surface of the fæcal masses when microscopic examination of his stool was made at intervals of four or five days during the following three weeks. There was a progressive decline in the number of polymorphonuclear leucocytes and endothelial cells until, on the twenty-sixth day, the latter had entirely disappeared, and only an occasional leucocyte could be found. The bacillary exudate

had now become replaced by one that consisted almost entirely of columnar epithelial cells.

At this time (the twenty-sixth day) the patient was about his business, but distinctly below par. He had a mild secondary anæmia and complained of dull uneasy sensations in the abdomen.

Inspection of Plate 3, fig. 2, will show the state of affairs on this day. It will be seen that the pathology of the colon at this stage had been reduced to a desquamative process involving the columnar epithelial cells of the mucosa, and unaccompanied by any marked suppuration. The process apparently was not limited to the cells on the surface of the mucosa, but would seem to have extended at least a short distance up into the glands of Lieberkuhn, for a number of cells were found which, though partially degenerated were, in all probability, goblet cells. On the thirty-third day the patient's stool was soft and contained considerable mucus in which, however, only a few scattering cells could be found. He was allowed gradually to return to full diet and was given instructions to report to the microscopist at intervals of about a week.

CASE R

American woman, aged 35 years. While on a visit in Stotsenburg, Pampanga, she contracted a mild attack of bacillary dysentery from the acute manifestations of which she recovered under treatment with salines, in a few days. She then returned to Manila and about a week later came down with a typhoidlike fever This ran a mild course for about three weeks and she convalesced rapidly. Several attempts were made during the course of her illness and afterwards to secure a Widal reaction but it always was negative. On leaving the hospital the patient resumed her normal diet and social life, but within a few weeks began to experience vague abdominal discomfort. She lost weight and developed a low-grade secondary anæmia. There was no diarrhœa, her stools being almost constantly formed.

Eventually, the case was referred to me for study. The first fæcal sample submitted was formed and normal in appearance except for a streak of thick, tenacious, brown mucus adherent to the surface. The interior of the fæcal mass contained no more mucus than one ordinarily encounters in a normal stool. The outlying mucus was rich in cells, however, most of them being epithelial cells of the columnar type cast

off from the mucous membrane. These cells had undergone degeneration and maceration to the extent that they were considerably distorted. Only occasional leucocytes were to be seen, any accompanying suppurative process that may have been present being apparently very mild. These features of the exudate will be seen on inspection of Plate 4, fig. 1, which is of a field in which the cellular débris was diffuse. Other fields showed blocks of columnar cells similar to those shown in Plate 3, fig. 2. While retaining much of their natural form, the nuclei of these cells had undergone pyknotic degeneration and the cytoplasm was homogeneous and formless.

A diagnosis of post-dysenteric ulceration of the bowel was made. The patient was placed on bland diet, colonic irrigations, and mild laxatives. Her general condition improved, as did her blood picture. Resumption of normal diet, however, brought about a return of the general symptoms and a reappearance of the mucus and cells. In fact, at no time during the period in which I had the case under observation was her stool entirely free from mucus and cellular débris. She relapsed in this way several times, although at no time did she develop markedly acute symptoms. Eventually, she was sent back to the United States and I lost further track of the case. I found neither protozoa nor helminths in this patient's fæces.

CASE T

An American boy, 5 years old. He and his father and mother all developed bacillary dysentery on the same day. All three cases ran a mild course. I did not have the opportunity to follow the cases of the father and mother, but their clinical recovery, at least, seems to have been complete. The exudate passed by the child at onset was typically bacillary, and he was running a temperature of 101° to 102° F. Serum was refused by all three and treatment consisted of the administration of saline laxatives and regulation of the diet. On the third day, the father brought me a fæcal specimen from the child and presented it to me with the remark that it was scarcely worth examining, because the child was perfectly well and playing about the house. The specimen was a large, yellow, formed mass of fæces, superficially normal in appearance. Closer inspection, however, showed it to be covered with the familiar coating of glistening mucus, which was streaked with blood.

The cellular content of this mucus is well shown in Plate 4, fig. 2. The exudate will be seen to be composed of erythrocytes, polymorphonuclear leucocytes, and degenerated columnar epithelial cells, together with cellular bodies of uncertain origin. It will be seen to present points of similarity to the exudates shown in Plate 4, fig. 1, and Plate 3, fig. 2. In other words, although the exudate had lost most of its bacillary characters, a suppurative process was still in progress accompanied by desquamation of the cells of the mucosa.

I explained to the father that his child was far from well and, on the contrary, needed careful dieting and treatment. Apparently this advice went unheeded and I did not hear of the case for several weeks, when I learned that the child had been losing weight and had been taken to the hills. A few weeks later the child developed severe intestinal symptoms and was brought back to Manila. Examination of the stool at this time gave evidence of a disturbance extending throughout the entire intestinal tract. The specimen sent to me contained lumps of undigested meat and other food and masses of mucus. The latter contained considerable epithelium and scattering pus cells. Another attempt was made to impress upon the parents the importance of caring for this condition, but the family physician later reported to me that he was unable to enforce his dietary and other regulations. I saw nothing further of the case.

CASE P

An Englishman, 33 years of age. While on a business trip to Iloilo he contracted bacillary dysentery which ran a sharp course for a day or two. In the interim he was treated with emetime and bismuth, so that he was able to board a steamer and return to Manila. He continued the treatment en route. His physician, doubting the original diagnosis of amœbic dysentery, referred the patient to me for a check on it. This was on the sixth day after the onset of symptoms. At this time the patient's stool was mucofæculent. It contained a rich leucocytic exudate, numerous endothelial macrophages, and blood. No amœbæ were found.

As the constitutional symptoms had abated by this time, the patient was placed on saline laxatives and restricted diet. Within a few days his stools had become formed to hardness, but the fæcal masses were smeared with mucus rich in cellular exudate. Plate 5, fig. 1, shows this exudate on the fifteenth day.

As will be seen from inspection of the figure, the essential features of the bacillary exudate are still present, though the process was obviously one of low toxicity. In all probability the persistence of this exudate was due rather to an extension of the infection to new areas on the bowel than to a persistence of the original involvement. It formed a striking illustration of the fact that the bowel may be undergoing considerable damage at a time when the clinical symptoms and gross appearance of the stool give no inkling of the truth. However, as the patient was able to pursue his customary occupation, no specific treatment was given, but he was kept on soft diet, mild colonic irrigations, and mild laxatives, notwithstanding his appetite was fair.

On the twenty-second day, his stool was formed but not hard. It still contained considerable cell-laden mucus, however. Plate 5, fig. 2, represents a photograph from a preparation made on that day. It will be seen that the regressive process was well on its way. There is total absence of macrophage and "epithelioid" cells. This is in sharp contrast to the previous picture in which cells of several types showing varying degrees of degeneration are scattered throughout the field. Annular degeneration of leucocyte nuclei still is present, to be sure, but that is a phenomenon that is seen in inflammatory processes other than bacillary dysentery.

The dietary régime and colonic irrigations were continued and on the twenty-ninth day the stool, though containing some mucus, yielded only scattering cells so degenerated that they could not be classified. The patient had gained weight and his general condition of health seemed excellent. He was told to resume his normal diet cautiously and report to the microscopist at intervals of about ten days. He has since shown no tendency to relapse, either clinical or microscopic.

When exudates of the type described in connection with these four cases are rich, they may present a superficial resemblance to the exudate of acute bacillary dysentery, for which they may be mistaken by the novice or the careless worker. However, a little careful study, checked by preparations stained with hæmatoxylin and eosin, will obviate mistakes. The type of predominating cell, of course, rules out any acute suppurative or toxic process. Moreover, the type of cellular degeneration will be seen to present certain differences.

In a general way, these four cases all ran a similar course, but the first three will be seen to have differed from the last

in that they developed a distinct desquamative stage unaccompanied by any marked suppuration, whereas the last would seem simply to have passed through the normal stages of cellular involution consequent upon an access of bacillary dysentery of moderate severity, with the shedding of a considerable number of epithelial cells. This desquamative process I already have described.(4, 5) It is one I have seen many times in post-dysenteric cases, particularly those of bacillary origin. It is what might be styled a distinct entity, and is one that should not be confounded with what sometimes is seen in the late stages of the extremely fulminating types of dysentery. In the latter, the clinical condition of the patient rapidly grows worse until it is grave in the extreme. The bowel discharges become liquid, the serous fluid being deeply blood-stained and heavily laden with epithelium. As the destruction of the mucous membrane rapidly progresses, the mucus disappears from the stools and its place is taken by necrotic sloughs or even casts.

The process I am here describing is accompanied by no such phenomena. The patient is not acutely ill, and the stools usually are fæculent and formed. No tissue sloughs are formed, but occasionally masses of cell-laden mucus are cast off that superficially resemble sloughs. Blood is conspicuous by its absence. The striking feature of the exudate lies in the type of degeneration shown by the cells. This would appear to consist, as I have said, largely in maceration and plasmolysis of the cells as a result of the unfavorable physical environment in which they find themselves on being cast off from the mucosa. In as much as the fæcal mass usually is formed and moves rather slowly, this influence works on the cells for a matter of hours. In consequence, the protoplasm appears to undergo a process of partial liquefaction with the result that the cytoplasm loses its finer structure and the nucleus becomes reduced to a homogeneous blob of what has been chromatin. This tends to be drawn out in making a smear preparation and it appears as coarse shreds and fibers when stained with hæmatoxylin. Polymorphonuclear leucocytes, when present, remain fairly intact, but their nuclei are homogeneous or pyknotic to a degree greater than that seen in healthy leucocytes, and never exhibit the annular degeneration characteristic of truly suppurative processes. Erythrocytes are conspicuous by their absence.

In short, the cytology of this exudate bears not the slightest resemblance to that of bacillary dysentery, and it needs only

cursory analysis to make that plain. Moreover, it is not necessarily a transient phenomenon, for I have known the condition to persist more or less continuously for months at a time.

I can offer no explanation of this strange appearance, especially as it seems not to be a feature of an inflammatory process, in the strict sense. How much of it is mechanical and the result of erosive action of formed fæces on a mucus membrane rendered unstable as to its attachments by a preëxisting inflammatory process, I cannot say. It may be consequent upon œdema of the gut wall. When this desquamative process becomes finally established, the exudate consists of little else than mucus and columnar epithelial cells.

At all events, it would seem quite clear that considerable areas of the gut become denuded of their protective epithelium. Unless this is pushed off in some reparative process, or immediately replaced by other cells, it is difficult to see why more or less extensive areas of infection do not develop. That such infection does occasionally occur I shall endeavor to show by the next case, which is typical of several of its kind that I have seen during the past few years.

CASE L

American male, aged 43 years. It is a matter of regret to me that I have not a complete history of this case and I can only report on it as it came to me. The observations made, however, tell a story of their own so I have no hesitation in citing it here. This man had resided in the Philippine Islands for many years and was engaged in the lumber business in Occidental Negros. About six months prior to the time I saw him, he suffered a severe attack of dysentery. From his description I have no doubt that this was of the bacillary type. He received such treatment as was available at the lumber camp but, of course, there was no serum on hand. The dysentery ran a very acute course, and his convalescence was prolonged. Eventually, he was able to resume work, but he steadily lost weight and the general decline in his health was marked. Dull pain in the abdomen persisted, and his stools remained mucoid and soft in consistence.

As he failed to improve he came to Manila. By this time he was unable to go about, so his physician placed him in the hospital. His condition there became very serious and a fatal outcome seemed imminent. He had a pronounced secondary anæmia, a leucocytosis of about 14,000, and a differential blood count showed an eosinophilia of 18 per cent.

The case was then referred to me for study. He had been on liquid diet, and his stool consisted almost entirely of a thick creamy mass of pus. I frequently made stained preparations of this, and never found endothelial cells. Occasionally, a stray mononuclear blood cell or a plasma cell would be discovered, but the exudate, to all intents and purposes, consisted entirely of polymorphonuclear neutrophiles, the nuclei of which showed the ordinary type of annular degeneration. Each preparation made contained a few amœbæ in the precystic stage, but they were degenerated, and the man returned to his station before I could determine the species of the amœbæ. In addition to this, he had a moderately heavy infestation with hookworm. The features of this exudate are pictured in a very characteristic field as Plate 6, fig. 1. Repeated efforts were made to recover *Bacillus dysenteriæ* in culture, but without success.

Notwithstanding the serious condition of the patient, it was deemed wise to rid him of his hookworm infection. Accordingly, he was given 10 cubic centimeters of carbon tetrachloride, from which he experienced no serious discomfort. As a result of this he passed a large number of worms. No worm count was made, because only the first stool was saved, but this was seen to contain many hookworms.

He was then placed on a strict diet, from which all bulky or irritating food was excluded, and given mild colonic irrigations. This treatment was continued for three or four weeks, during which time the pus gradually disappeared from his stools. He then began to gain weight rapidly. At the end of a year the man had regained his normal weight and was in perfect health, he told his physician, aside from a slight degree of constipation.

On reviewing the evidence it will be seen that this case presented the following outstanding features:

1. A severe attack of dysentery, probably of bacillary origin; inadequately treated.

2. Prolonged convalescence, in consequence, succeeded by general decline in health and persistently abnormal stools. No treatment during this period.

3. The discharge of creamy, purulent matter from the intestine with accompanying leucocytosis and marked prostration.

4. The exudate consisted almost entirely of polymorphonuclear neutrophiles. Macrophages never were found. *Bacillus dysenteriæ* could not be recovered in culture on repeated attempts. Therefore, there was no evidence of bacillary dysentery.

5. Amœbæ were present, but only in the precystic stage. Trophozoite forms of amœbæ never were found. Therefore, the case was not one of acute intestinal amœbiasis.

There was, in consequence, no evidence that the process was dysenteric in nature.

I think there is no reasonable doubt that the purulent discharge from this man's intestine was the direct result of inadequate treatment of his dysentery and his failure to receive proper after-care. Such a case coming to the microscopist unaccompanied by a clinical history very likely would be mistaken for one of bacillary dysentery unless a careful search were made for macrophages. Such a search, of course, always should be made. The diagnosis of acute dysentery by the study of the cellular exudate is a safe and accurate procedure, but judgment never should be rendered until the microscopist has thoroughly analyzed his material. A diagnosis of bacillary dysentery made on the presence of a heavy leucocytic exudate, uncorroborated by the finding of endothelial macrophages and evidence of toxic necrosis, is entirely unwarranted and, as this case illustrates, may lead to serious mistakes. It is true that most, possibly 95 per cent, of the heavy polymorphonuclear exudates prove to be of bacillary origin, but heavy pus exudates occur with sufficient frequence in suppurative conditions in the colon as well as in balantidial dysentery to make it absolutely essential that the microscopist should assemble the complete picture, even resorting to stained preparations, before making a diagnosis of bacillary dysentery. These remarks are based on one or two unhappy mistakes I, myself, have made. Fortunately, these were unattended by serious consequences.[1]

One of the most striking illustrations of the need for caution in the interpretation of an aberrant picture that I ever have seen is afforded by the following case:

CASE M

The patient was a girl, aged 12 years, who developed bacillary dysentery during the course of an outbreak of mild degree

[1] Connal and Young, Trans. Roy. Soc. Trop. Med. & Hyg. 16 (1922) 90, in reporting a case of infection with *Isospora hominis* in a young European in Nigeria, speak of the repeated occurrence of columnar epithelial cells in the fæces of their patient. He gave a history of chronic amœbic dysentery considerably antedating the discovery of his coccidial infection. Wenyon and O'Connor, Human Intestinal Protozoa in the Near East, also mention the presence of these cells in fæces without, however, entering into a discussion as to their significance.

among the Americans and Europeans in Manila in July of this year. At onset, the child's temperature mounted rapidly to 102° F., and there were abdominal cramps of moderate severity accompanied by the passage of frequent bloody, mucoid bowel movements. The general condition of the patient remained good, however.

On a microscopic diagnosis of bacillary dysentery, the attending physician administered two doses of antidysenteric serum of 20 cubic centimeters each. As a result of this, the patient's temperature fell to normal the following day, the pain subsided, the bowel movements lessened in frequence and by the fourth day convalescence seemed to be well established. The stool on that day was soft and mucofæculent, but contained considerable pus, scattering erythrocytes, and an occasional macrophage, showing that the bacillary process had subsided almost completely and had been succeeded by the usual residual suppurative process.

Despite the fact that the clinical condition of the patient was entirely satisfactory, the attending physician ordered the administration of a colonic irrigation of physiologic salt solution and hydrogen peroxide. This caused great pain and considerable distention of the bowel which persisted through the night. The following morning the child's temperature was normal, but toward noon it gradually rose until a maximum of 101° F. was reached. A copious, watery stool was passed, which almost immediately after was followed by a blood-tinged, watery stool containing masses of cell-laden mucus.

At first glance, this exudate closely resembled that of bacillary dysentery. The cellular exudate was massive, and showed the presence of numerous erythrocytes and an occasional macrophage. The first impression was that there had been a recrudescence of the dysenteric process. The general form of the cells was different, however, and there seemed to be other differences of a somewhat intangible nature. Accordingly, a number of films were fixed and stained. As a result of this procedure it was discovered that the smaller cells that composed the bulk of the exudate were not polymorphonuclear neutrophiles, but were, instead, circular to oval cells with deeply staining pyknotic nuclei. The cells were hydropic and the nuclei were excentrically placed in the majority of the cells. Here and there were encountered macrophages and, occasionally, small groups of polymorphonuclear neutrophiles. These elements are shown in the figures composing Plate 8.

I am not prepared at this time definitely to classify these mononuclear cells. I am inclined to regard them provisionally as plasma or irritation cells; but one of my colleagues, a pathologist of wide experience, who kindly studied the exudate for me, hazarded the opinion that they might be hydropic epithelial cells. While not entirely dissenting from this view, I beg to call attention to Plate 8, figs. 2 and 3. Figure 2 shows, at A, one of these cells which had phagocytosed an erythrocyte—a most improbable feat for an epithelial cell; fig. 3 shows two cells, at E, which I think there is little doubt are degenerated columnar epithelial cells. Their nuclei will be seen to be approximately in their normal position, and they bear no real resemblance to the cells under discussion. Figure 1 shows a large field of this exudate; it may be compared with Plate 7, fig. 2.

At all events, I interpreted this curious picture mainly as the expression of a rather energetic reaction of the intestinal mucosa to the strong hydrogen peroxide solution. The macrophages may have represented a mild extension of the bacillary dysentery to a new area of the bowel. The leucocytes probably were associated with the latter, and also with the residual secondary infection of the bacillary ulcers formed on the initial attack.

These features of the exudate were discussed with the physician who had been called on the case after the administration of the hydrogen peroxide irrigation, and it was agreed that the bulky exudate probably was, in greater part, the manifestation of a profound reaction on the part of the intestine to the irritation produced by the hydrogen peroxide. We were inclined to regard the presence of macrophages as possibly due to an extension of the dysenteric process to a hitherto uninvolved portion of the gut. In view of the facts that the elevation of temperature was not extreme, and that the general condition of the patient was good, it was decided to defer the further administration of serum for a few hours. Shortly after this the patient's temperature fell, and it became normal early the next day. From that time on, convalescence was uninterrupted.

Aside from the clinical lesson, upon which I need not dilate, there is a valuable lesson to the microscopist afforded by this occurrence. It consists in an exudate which on initial inspection appeared to bear the characters of a typical bacillary exudate, but which on brief study of hastily stained preparations proved to be something entirely different. These differences, it

has been seen, influenced the clinical management of the case at that period.

Moreover, this picture should be carried in mind by the microscopist. It is the practice of some physicians to administer colonic irrigations, sometimes with more or less irritant solutions, in conjunction with other antidysenteric treatment. Under such circumstances, the persistence of a massive cellular exudate, at a time when the patient is progressing well clinically, should arouse curiosity as to its nature. In this event stained preparations should be studied before it is assumed that the patient is suffering from a serious extension of the bacillary process.

It is with some hesitation that I take up the final topic of this paper—the presence of eosinophiles and plasma cells in the watery discharges accompanying allergic reactions in the gastrointestinal tract. My object simply is to record some rather incomplete observations I have made in a few cases in order that I may give the cue to other workers whose opportunities may lead them to the study of a greater number of cases of intestinal allergy under more favorable conditions for study than I have enjoyed. I believe this is important for the following reasons:

1. A heavy eosinophilic exudate may simulate the leucocytic exudate of bacillary dysentery in the fresh preparation, especially as the glistening eosinophile granules bear a very striking resemblance to the fatty and other cell inclusions in bacillary dysentery.

2. The value the cytology of this eosinophilic exudate may hold in establishing a differential diagnosis between intestinal allergy and bacillary dysentery or cholera.

3. The light that the presence of large numbers of eosinophiles in intestinal allergy may throw on the entire question of the significance of eosinophilia in general. To me this is especially suggestive, in view of the current beliefs concerning eosinophilia in asthma, certain dermatoses, parenteral injections of serum, and other conditions in which the introduction of foreign proteins seems to play a part. My observations on eosinophilia in various parasitic invasions in natives of the Philippine Islands are leading me to suspect that it is an expression more of the reaction on the part of the host organism to a foreign and unwelcome protein than it is to a specific toxin, as such, elaborated by the parasite.

For the purpose of outlining the subject, so far as it pertains to intestinal allergy, I shall briefly discuss three cases.

CASE BL

American woman, aged 46 years. She had served for many years as a missionary in China and the Philippine Islands. During her sojourn in the East she had had both malaria and dysentery. Whether her dysentery was of the amœbic or the bacillary type I cannot say. Her stools never were entirely normal and, though I occasionally encountered Charcot-Leyden crystals, I never, in the two years in which I intermittently studied her case, discovered parasites of any species. Periodically, however, especially when her stools became constipated or she suffered from some gastrointestinal upset, large numbers of columnar epithelial cells and considerable mucus appeared in her stools. She also was extremely sensitive to fish, and was made violently ill by it several times during the period of observation. This brought her frequently into the hospital where she sometimes had to remain for several days. At other times she suffered from vague abdominal discomfort, and was anæmic and unfit to perform her duties.

During one of these periods and at a time when her stool contained considerable mucus and epithelium, she ate a small amount of fish and a few hours later came down with abdominal cramps, purging, and vomiting, accompanied by considerable prostration. A specimen of bowel evacuation sent to me was watery and bore a close resemblance to the rice-water stool of cholera. This appearance was due to the presence of innumerable flakes of mucus containing columnar epithelial cells. The making of stained preparations was attended with considerable difficulty because of the watery nature of the stool, which not only made it difficult to fix the material on the slide, but damaged the cells considerably.

A field from a preparation of this stool is shown as Plate 6, fig. 2. The exudate will be seen to consist mainly of columnar epithelial cells showing the same type of degeneration as has been discussed above. Scattered about among these epithelial cells, however, are numerous eosinophiles. The nature of the material makes it difficult to show these clearly, so that I must ask the reader to accept my statement that they were very numerous. The attack subsided within a few hours and with it the eosinophiles disappeared from the exudate.

CASE V

Filipino male, aged 23 years, employed as an attendant in my laboratory. He was seized with cramps, vomiting, and purging about ten hours after he had eaten a heavy meal of shrimps. Though I did not know it at the time, he told me afterward that shrimps had made him sick before. The exudate in his stool was so rich in cellular content that I made a provisional diagnosis of bacillary dysentery and sent him to the hospital. There he was given a purge of sodium phosphate and 20 cubic centimeters of polyvalent antidysenteric serum. His symptoms almost immediately subsided. His stool passed early the following day, though only semiformed, contained neither mucus nor cells in recognizable amounts.

The material obtained from this case was in better condition for study than that obtained from the two other patients in this group. Inspection of Plate 7, figs. 1, 2, and 3, will show that this exudate was made up of two principal types of cells, eosinophiles and plasma cells. Cells of the latter type seem to be present in a variety of conditions involving the more superficial portions of the mucosa. In fact, they appear to be among the first to respond and the last to disappear in bacillary dysentery and allied conditions.

An interesting feature of the exudate in this case was the distinct separation between the eosinophiles (fig. 1) and the plasma cells (fig. 2). The segregation was almost complete in all parts of the films. Polymorphonuclear neutrophiles were present in very small numbers; three are shown in fig. 3. Other blood cells were present in insignificant numbers.

Inspection of the figures, particularly fig. 3, will show that the nuclei of these eosinophile cells bears not the slightest resemblance to the polymorphous nucleus of the eosinophiles encountered in blood smears. The nuclei are distinctly annular with a central granule like a karyosome. Usually one or, at the most, two of these are found in each cell. These are sharp and clean-cut like the "ring nuclei" in degenerated pus cells and do not look as if they could be the product of the typical washed-out nucleus of the eosinophile cell of the blood stream. However, it will be seen that the nuclei of the polymorphonuclear neutrophiles in this case have undergone annular degeneration.

CASE PN

American male, 38 years old. The clinical symptoms and the gross appearance of the stool were almost identical with

those seen in the two other cases. The exciting agent here was clams, which had produced other similar attacks in this patient in the past. He was very violently ill for several hours, but recovered promptly and completely under purgation and stimulation. Unfortunately, I did not receive one of the earlier stools for examination, the specimen provided me having been passed some three hours after the onset. It presented the same technical difficulties as the others. However, two successful preparations were made which showed scattered clumps of eosinophiles. There also were a few isolated plasma cells and an occasional leucocyte. One of the clumps of eosinophiles is shown (Plate 7, fig. 4). The cells are badly macerated and their nuclei are indistinct, but there is no doubt of their identity.

Such are the data I have to offer on this phase of the microscopy of intestinal exudates. I realize it is very indefinite, but I submit that the lead is worth following up by those to whom the opportunity comes.

LITERATURE CITED

1. ANDERSON, JOHN. A study of dysentery in the field, with special reference to the cytology of bacillary dysentery and its bearing on early and accurate diagnosis. Lancet 2 (1921) 998.
2. BAHR, PHILIP, and WILLMORE, J. GRAHAM. Dysentery in the Mediterranean Expeditionary Force (a reply to G. B. Bartlett). Quart. Journ. Med. 11 (1918) 349.
3. HAUGHWOUT, FRANK G. Observations on the differential diagnosis of the dysenteries. Journ. Philip. Is. Med. Assoc. 1 (1921) 53.
4. HAUGHWOUT, FRANK G. Observations on the microscopical picture in dysentery and other intestinal disorders. Trans. 5th Congr. Far Eastern Assoc. Trop. Med. Singapore. September, 1923. (In press.)
5. HAUGHWOUT, FRANK G. The practical microscopic diagnosis of dysentery. Med. Bull. No. 3 (1924) Inst. Med. Res. Kuala Lumpur, F. M. S. (In press.)
6. HAUGHWOUT, FRANK G. The microscopic diagnosis of the dysenteries at their onset. Journ. Am. Med. Assoc. 83 (1924). (In press.)
7. WILLMORE, J. GRAHAM, and SHEARMAN, CYRIL H. On the differential diagnosis of the dysenteries: The diagnostic value of the cell-exudate in the stools of acute amœbic and bacillary dysentery. Lancet 2 (1918) 200.

ILLUSTRATIONS

[All figures are photomicrographs of fields in the author's preparations from the exudates of the cases described in the text. The subjects were posed by the author, and the photographs, with the exception of those forming Plate 8, were taken by Maj. George R. Callender, M.C., U.S.A., of the United States Army Medical Department Research Board, stationed in Manila. All preparations were wet fixed in Schaudinn's fluid. The preparation shown in Plate 1, fig. 3, was stained with Heidenhain's hæmatoxylin and picro-acid fuchsin; that of Plate 6, fig. 1, with Heidenhain's hæmatoxylin. All the others were stained with Delafield's hæmatoxylin and eosin.]

PLATE 1

FIG. 1. Exudate of bacillary dysentery in which the macrophage cells are uniformly distributed. This is a relatively thin portion of the smear, but the high proportion of polymorphonuclear leucocytes is apparent. Note evidences of toxic degeneration in all types of cells, especially the macrophage (M).

2. Exudate of bacillary dysentery in which the macrophage cells are relatively more abundant and occur in clumps. The dark bodies lying in clear, vacuole-like spaces are erythrocytes that have been phagocytosed by the macrophages.

3. High-power view of macrophage cells and polymorphonuclear leucocytes. Note the complete dissolution of the nuclei of the macrophage cells (compare with Plate 3, fig. 3) and the annular degeneration (ringing) of the nuclei of the polymorphonuclear leucocytes. The cell in the upper right corner (L) probably is a large mononuclear leucocyte from the blood stream.

PLATE 2

FIG. 1. Exudate of amœbic dysentery uncomplicated by secondary bacterial infection of amœbic ulcers. Note the trophozoite of *Entamœba histolytica* (A), containing ingested erythrocytes and the Charcot-Leyden crystal (C). The dark bodies occurring singly and in clumps are erythrocytes. Other blood or tissue cells, with the exception of a degenerated leucocyte, will be seen to be absent.

2. Exudate of amœbic dysentery, complicated by marked secondary bacterial infection of amœbic ulcers. A trophozoite of *Entamœba histolytica* (A) will be seen together with numerous erythrocytes. The salient feature of the field is afforded by the numerous polymorphonuclear leucocytes. They do not, however, constitute the massive content shown in Plate 1, fig. 1, and, moreover, they will be seen to be practically intact, showing evidence of neither toxic necrosis nor proteolysis.

PLATE 3

FIG. 1. Exudate in mucofæculent stool of an untreated case of bacillary dysentery, the sixth day after onset. Thin smear. Note particularly that evidences of toxic necrosis are not so marked as shown by the cells in Plate 1, fig. 1. Macrophage and "epithelioid" cell nuclei are almost intact.

2. Exudate in mucofæculent stool of same case as above on the twenty-sixth day after onset. Note that the former purulent exudate has been entirely replaced by one containing only desquamated columnar epithelial cells with an occasional leucocyte or plasma cell. The epithelial cells will be seen to have been cast off singly and in small sheets. At least one of these (G) probably is a goblet cell.

3. High-power view of a macrophage on the same preparation shown in fig. 1. Compare with Plate 1, fig. 3. Note that, while there is a rarefied area in the cell, the nucleus, though clearly involved, has not lost its characteristic form. This is indicative of the decline in toxicity of the process even on the sixth day. The body at the lower end of the macrophage cell is a mononucleated plasma cell that overlies the extremity of the other cell.

PLATE 4

FIG. 1. Exudate in post-dysenteric ulceration of the colon. Numbers of macerated columnar epithelial cells will be seen as well as one or two bodies that may be the remains of leucocytes. Note how the liquefied nuclear material has been drawn out in making the smear.

2. Exudate in the mucofæculent stool of a case of bacillary dysentery in a child on the third day after onset. The fæcal portion of the stool was formed to hardness. The stool retains many bacillary characters, but the most conspicuous bodies in the field are macerated columnar epithelial cells showing that the residual purulent process is accompanied by desquamation of mucosal epithelium. The same streaking of nuclear material shown in fig. 1 also is shown here.

PLATE 5

FIG. 1. Persisting bacillary process in an ambulant case, untreated by serum, on the fifteenth day after onset. All the elements of the bacillary exudate are here and probably indicate the extension of the process to a new area of the bowel. The stool was formed and fæculent to hardness.

2. Mucofæculent stool of the same case on the twenty-second day after onset. Note that the streaks of mucus are laden with polymorphonuclear leucocytes only, showing that the bacillary process had given way to a simple bacterial infection of injured areas in the mucosa. This is a very characteristic picture seen in the stools of former dysenterics.

PLATE 6

FIG. 1. Purulent discharge from the intestine of a man who had been insufficiently treated for bacillary dysentery six months before. This discharge was pure pus in which only occasional mononuclear blood or plasma cells were seen. A precystic amœba (A) appears near the center of the field.

2. Combined exudate of post-dysenteric colitis and intestinal allergy. All cells were badly macerated in the watery stool accompanying the allergic reaction, and very few of the eosinophile cells present are recognizable in the photograph. The cell at (E) unquestionably is an eosinophile. Other cells in the field are mainly columnar epithelial cells.

PLATE 7

FIG. 1. Clump of eosinophile cells in the serous exudate of a case of intestinal allergy. Note their mono- to binucleated condition and compare with eosinophile cells found in the tissues.

2. Clump of plasma cells in another portion of the same preparation as shown in fig. 1.

3. Clump of eosinophile and polymorphonuclear neutrophile cells in same preparation as figs. 1 and 2. Compare the nuclei of the eosinophiles with those of the neutrophiles.

4. Group of plasmolyzed and macerated eosinophiles from the watery stool of a man suffering from intestinal allergy following a meal of stewed clams.

PLATE 8

[Photographed by E. Cortes, Bureau of Science.]

FIG. 1. Typical field in exudate passed after administration of a colonic irrigation containing hydrogen peroxide. Note that the exudate consists almost entirely of hydropic cells with pyknotic nuclei. A macrophage is shown at M.

2. Clearer view of mononuclear cells. Note the cell at A, which has phagocytosed an erythrocyte. Compare these cells with those shown in Plate 7, fig. 2.

3. Pair of desquamated columnar epithelial cells, E, in the same exudate.

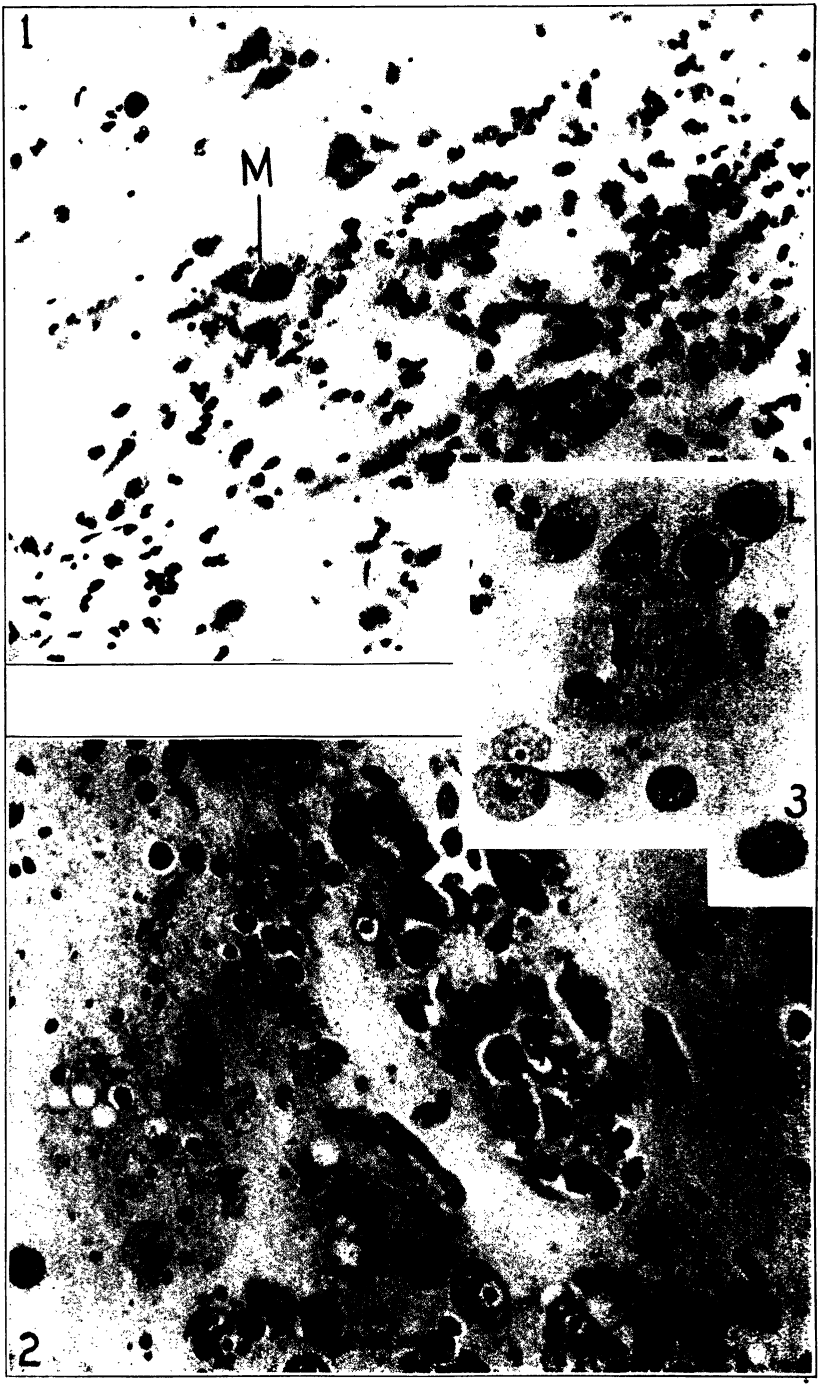


PLATE 1. TYPES OF BACILLARY EXUDATE.

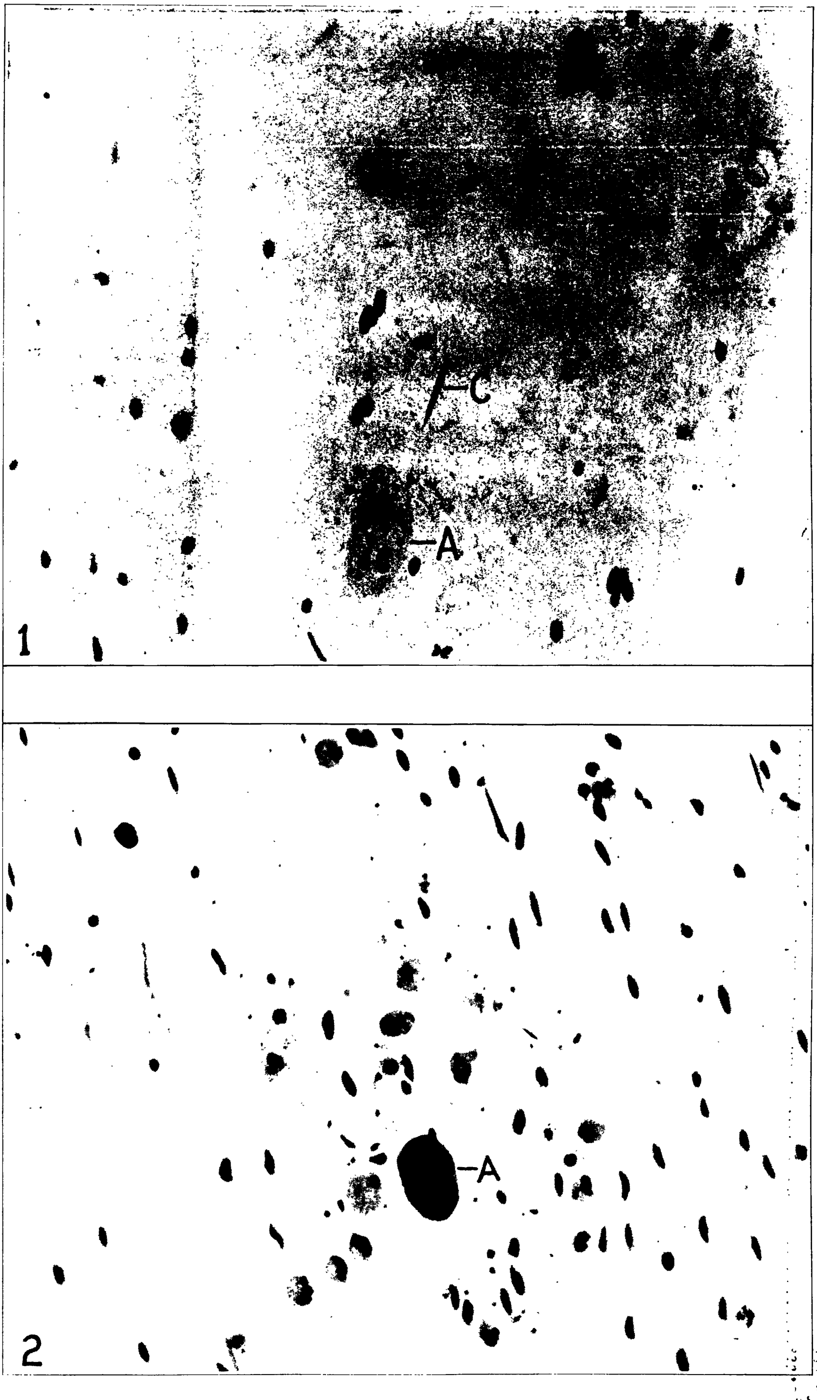


PLATE 2. TYPES OF AMŒBIC EXUDATE.

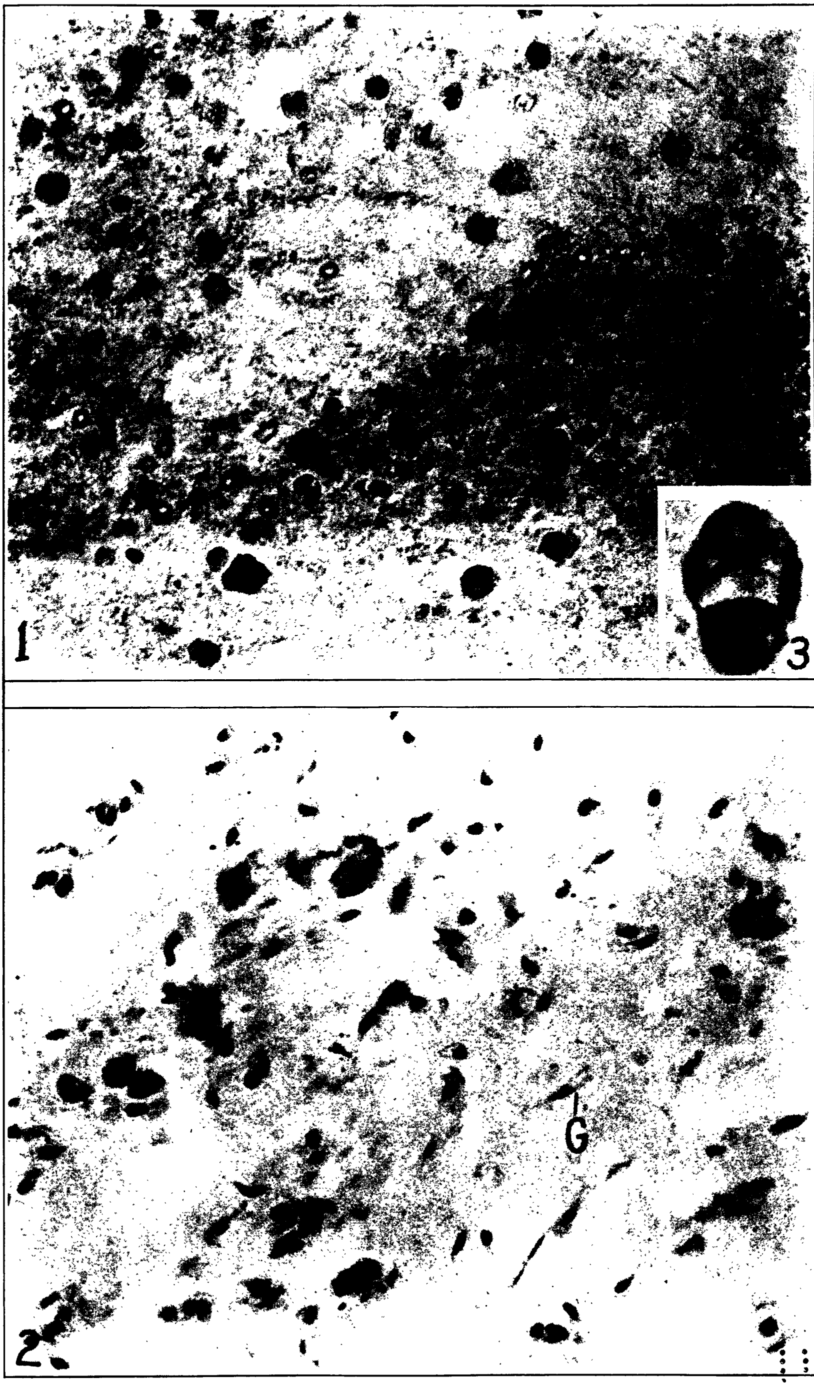


PLATE 3. EXUDATES FROM CASE B.

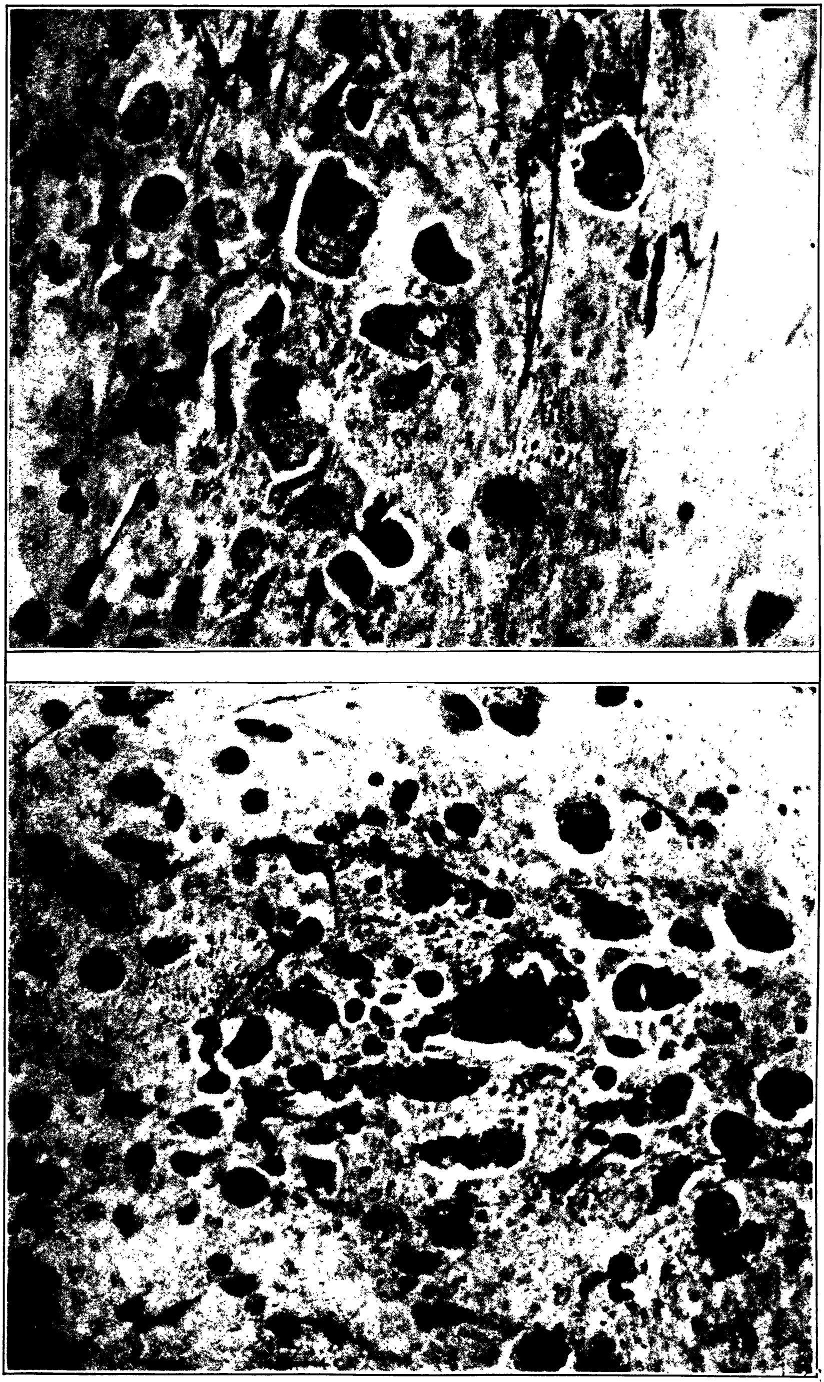


PLATE 4. EXUDATES FROM CASES R AND T.

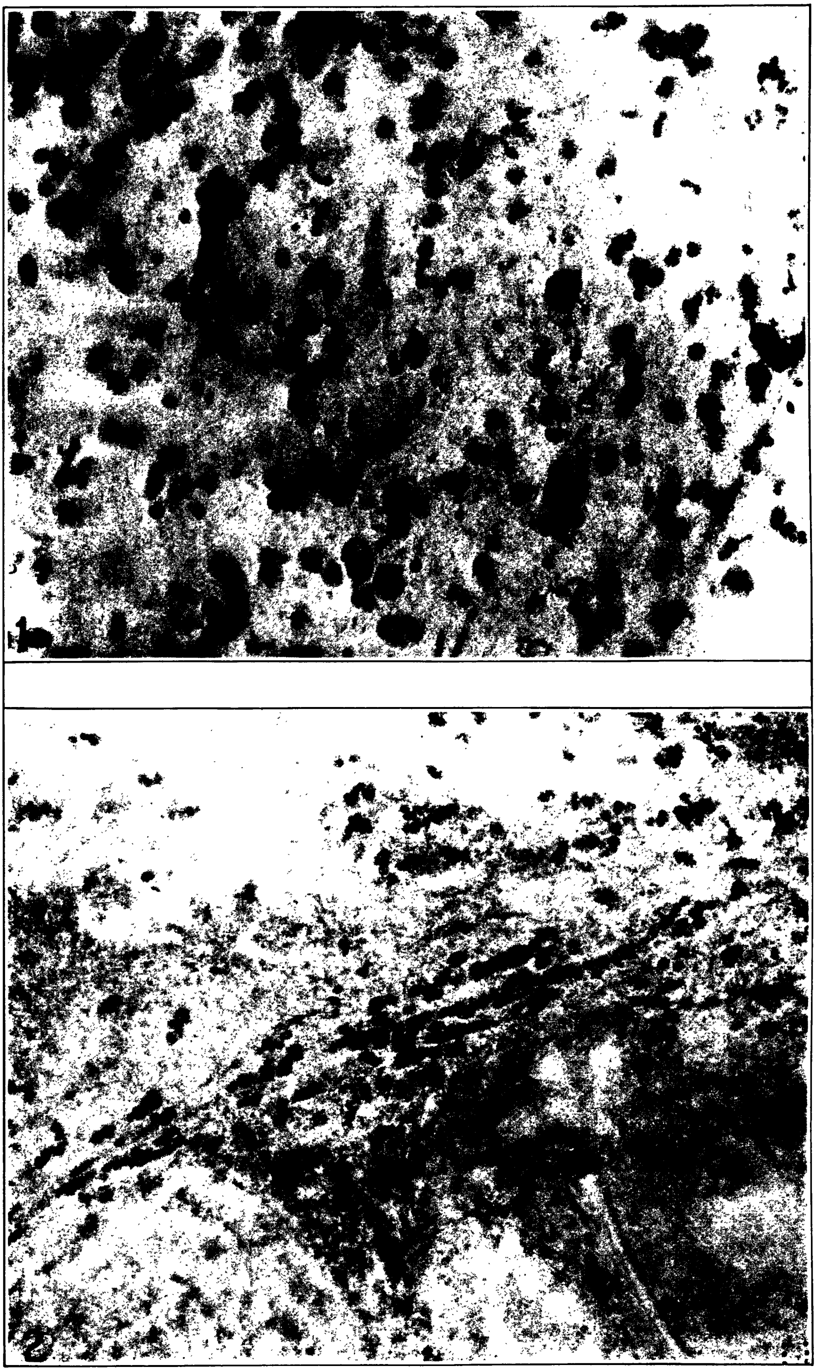
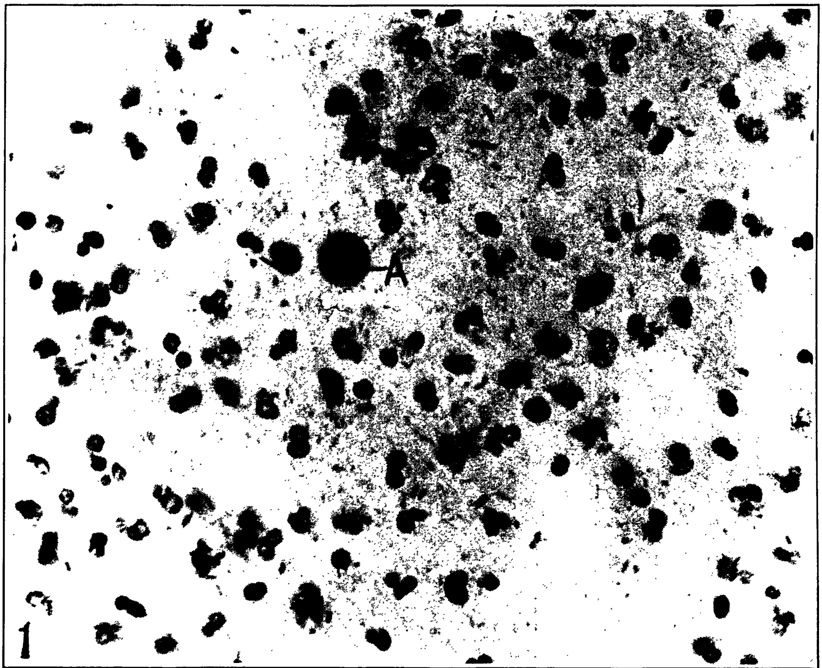


PLATE 5. EXUDATES FROM CASE P.



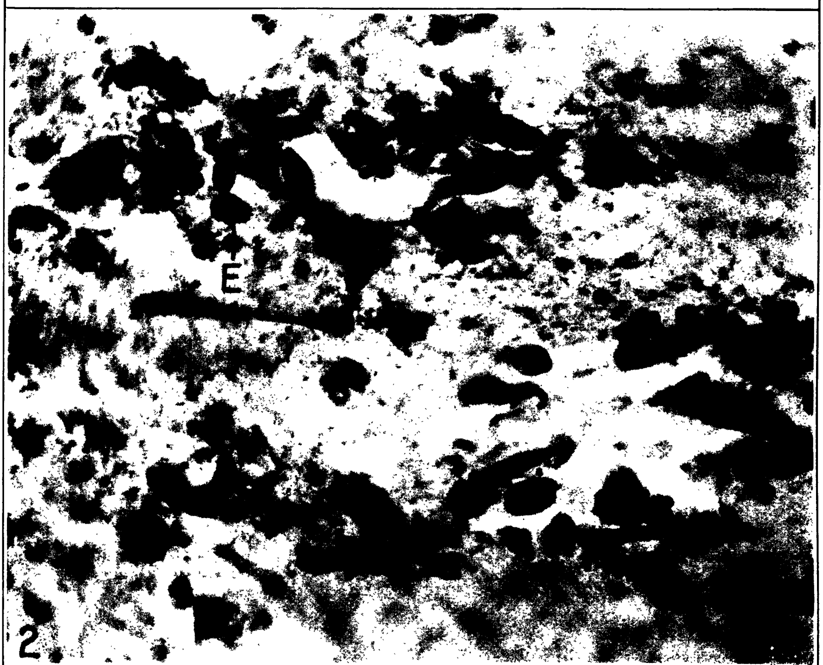


PLATE 6. EXUDATES FROM CASES L AND BL.

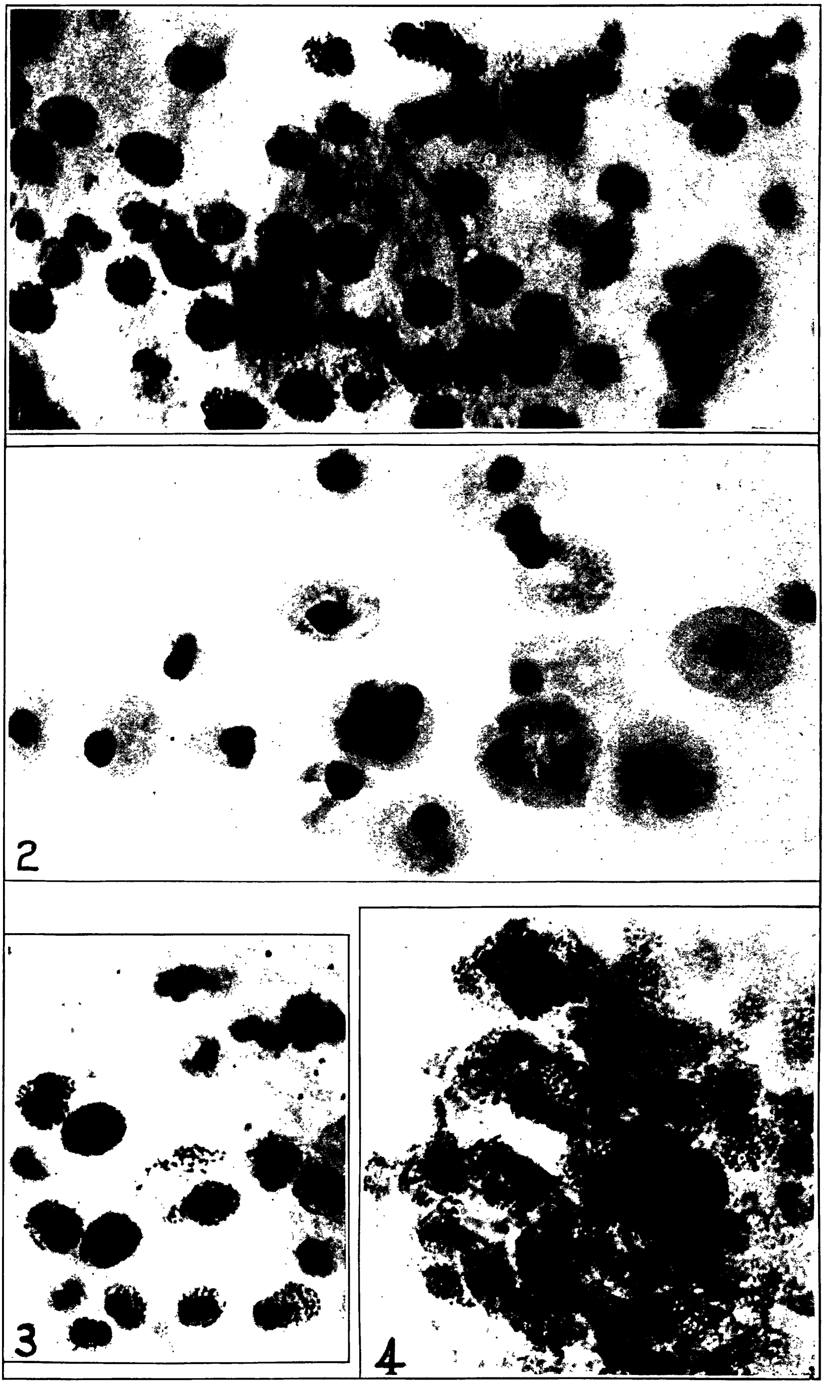


PLATE 7. EXUDATES FROM CASES V AND PN.

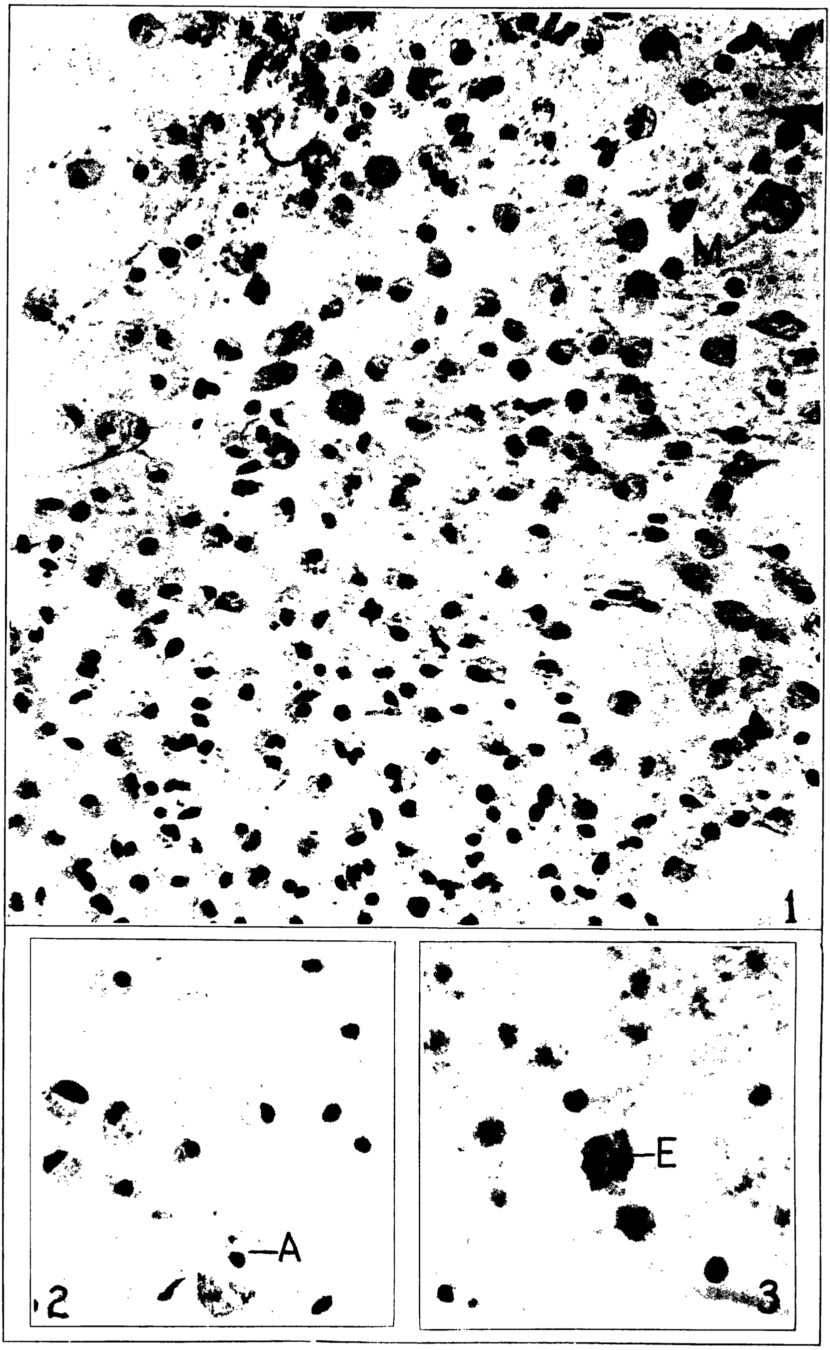


PLATE 8.

VOL. 25, NO. 5 NOVEMBER, 1924

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1924

205050

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science of the Government of the Philippine Islands

---

Manuscript intended for publication should be sent to the editor. One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Library, Bureau of Science, Manila, P. I.

The Journal is issued twelve times a year. The subscription price is 5 dollars, United States currency, per year. Single numbers, 50 cents each.

Subscriptions may be sent to the BUSINESS MANAGER, Philippine Journal of Science, Bureau of Science, Manila, P. I., or to any of the agents listed on the third page of this cover.

THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. 25 NOVEMBER, 1924 No. 5

A STUDY OF THE BUPRESTIDÆ, COLLECTED BY CHARLES FULLER BAKER IN SINGAPORE, BORNEO, AND THE PHILIPPINE ISLANDS

By JAN OBENBERGER
Of the Entomological Section of the Czecoslowak National Museum, Prague

FOUR PLATES

This paper is based on part of a collection of Buprestidæ, received from Charles Fuller Baker, made during his explorations in some localities of the Philippine Islands, in northern Borneo (Sandakan), and at Singapore.

The paper was nearly completed when I received a copy of an important study by W. S. Fisher.[1] The work of Fisher was also based on the Baker collections and was augmented by some new species, conserved in the collections of the United States National Museum, Washington, D. C. I have found still more new species, not yet described, in the collections sent to me and also in my rather rich collection which contains many of the rare species of the old collections of Meyer-Darcis and others. Most of the Buprestidæ herein mentioned belong to the same genera as those treated by Fisher; namely, *Agrilus* and *Trachys*.

Systematic studies in Buprestidæ are daily becoming more complicated and more difficult. Buprestid beetles are generally rare; their conditions of life are sometimes very specialized,

[1] New Coleoptera from the Philippine Islands, family Buprestidæ, tribe Agrilini, Philip. Journ. Sci. 18 (1921) 369 to 447.

and the number of specimens of most species in collections is small. The types are conserved in many private and public collections and are generally accessible to specialists only under great difficulties. Therefore, it is necessary to work on the same basis as did the earlier authors and to adopt all their findings, and on these earlier studies synopses must be built. In this connection, it is best to adopt an old and good key and to enlarge it by the addition of newly described forms. In the Oriental fauna there are few such keys for *Agrilus* and *Trachys,* the best ones being by Deyrolle. Generally, the descriptions of Kerremans are very superficial and, unless one can see the types, it is not easy to arrange them in the form of a key.

For the present study I have made keys which include all the species described by Fisher and also all my new species from the Philippines. I have added intentionally all the other species from Sandakan and Singapore, to indicate their natural positions. The agriloid Buprestidæ of the Oriental fauna can be divided into two great zoögeographical groups: the first, continental, comprising East India, Ceylon, Burma, Tonkin, Laos, South China, and southern Japan, excluding the Malay Peninsula; the second, comprising the Oriental islands, insular division, with all the Sunda Islands, Philippines, Formosa, Malay Peninsula, etc. There are numerous passages to the Papuan fauna.

Trachys and *Agrilus* are very old genera, and the species from different points of the Philippines, Sunda Islands, or Malay Peninsula are very similar; it is therefore not without reason that I have added them to my keys. I could not possibly follow the key established by Fisher, since most characters used by him are not mentioned in the earlier descriptions. His key is based on some characters adopted by Horn in his Revision of the Agrili of the United States, which has also made the study of North American Agrili superfluously difficult. My maxim in making keys is to make them workable to the greatest number of students; to make them easy, clear, and always where possible to use the characters of the upper surface, since some characters of the undersurface, such as the form of the tip of the prosternal process in Agrili, are rather variable. I have, however, adopted from the keys of Fisher all that seemed to me to be useful.

The descriptions of Fisher are excellent and very valuable; this circumstance has enabled me to work with them and to

introduce them in my keys without seeing the types; I hope that I have placed them correctly. The future specialist who wishes to review all Oriental insular Agrili or *Trachys* species can simply combine my keys with the completed keys of Kerremans and Deyrolle.

To this study I have added figures and sketches of all species mentioned. Types are deposited in the Baker collection when belonging to it; all other types cited here and some of the duplicates of the Baker types are in my own collection. I take this opportunity of thanking Prof. Charles Fuller Baker for having sent me this important material for study and for having given me a copy of the paper by Fisher for my use. I also thank Mr. Fisher for his kind assistance.

Genus **IRIDOTAENIA** H. Deyrolle

A specimen of but one species of this genus was sent to me for determination. The genus contains actually about sixty species, all except two of which inhabit the Oriental Region; the two exceptions are rather different forms, from tropical Africa.

Some species of *Iridotaenia* are characterized by different designs (longitudinal yellow fascia on the elytra) in the males; most of them are very rare in collections.

Iridotaenia sulcata Fabricius.

One specimen of this species was taken at Sandakan by Baker. It is a little smaller and narrower than my other specimens, from Ceylon, but in all other important characters is identical.

Genus **SAMBUS** H. Deyrolle

Key to the species.

a^1. Head with vertex distinctly gibbose. Head and pronotum bright red, disk purple, front bright green, pronotum with greenish tinge along lateral margin. Elytra coppery bronze, marked with irregular designs of white and pale yellow pubescence, the transverse zigzag band at apical fourth very distinct; 4 millimeters. (Mindanao.)
S. gibbosus Fisher.

a^2. Head with vertex not distinctly gibbose.
b^1. Surface of elytra tricolored.
c^1. Elytra with a half-oval purple or violaceous spot along lateral margin.
d^1. Head deeply grooved, slightly transversely rugose, clothed with pale yellow pubescence, becoming denser and longer on occiput, brilliant reddish purple. Rather robust, uniformly cupreous,

each elytron with a large, oblong lateral spot of beautiful reddish purple; prothoracic surface strongly punctate and concentrically rugose; 5.25 millimeters. (Luzon and Mindanao.)
S. bakeri Fisher.

d^2. Head moderately impressed on vertex, rather strongly transversely rugose, nearly hairless, brilliant green. Cupreous with golden reflections, sides of prothorax greenish, elytral lateral spot violaceous; prothorax surface finely sculptured; 4.5 millimeters. (Sulu Islands.) .... **S. adonis** sp. nov.

c^2. Elytra without lateral spots, with diverse designs on disk.

d^1. Larger; elytra with irregular black and green designs. Head and pronotum brassy green, the former with front bright green. Beneath black, with bronzy tinge, nearly glabrous. Head deeply grooved its entire length. The brassy green elytral areas clothed with white and yellow pubescence; 4 millimeters. (Luzon.) .... **S. parallelus** Fisher.

d^2. Æneous, elytra with large, transverse, dark æneous preapical and oval glabrous macula, common to both elytra, and with a small dark apical area on each side. Front brilliant blue. Beneath black, antennæ green, upper side of femora bluish; 3 millimeters. (Borneo.) .... **S. sandakanus** sp. nov.

b^2. Surface of elytra unicolored.

c^1. Elytra bronzy or æneous with green or cupreous tinge.

d^1. Pubescence on elytra uniform, not forming distinct designs, pale yellow. Entirely bright æneous above; front bright green, occiput bronzy. Beneath bright brassy green, clothed with silvery white pilosity; 4 millimeters. (Luzon.)
S. confusus Fisher.

d^2. Pubescence on elytra forming distinct designs, especially on apical part.

e^1. Vertex with a deep impression in the middle. Head and prothorax golden, the latter with the sides widely depressed. Elytra bronzy, densely golden pubescent, two spots on suture above middle, a transverse band below the middle, two spots or an interrupted band between this and the apex itself, naked; 2¾ lines (ex E. Sd.). (Samar.).
S. auricolor E. Saunders.

e^2. Vertex convex, with only feebly indicated median impression.

f^1. Smaller. Thoracic carina distinct. Antennæ green (male) or bronzy (female). Disk of prothorax with a rather deep depression on the inside of lateral carina. Head and pronotum brilliant green (male) or coppery (female), elytra bronzy and marked with irregular patches of white and pale yellow hairs; 4.5 millimeters. (Mindanao.)
S. ornatus Fisher.

f^2. Larger. Thoracic carina very indistinct. Antennæ black with blue tinge. Disk of prothorax without distinct lateral depressions. Olivaceous, head cupreous, prothorax golden. Elytra with pubescent designs formed of yellow pilosity only; 5.3 millimeters. (Philippines.)
S. philippinarum sp. nov.

c^2. Elytra dark, blue or black.

d^1. Elytra blue. Robust; entirely blue above, elytra marked with transverse bands of silvery white pubescence. Head rather deeply grooved; 7 millimeters. (Mindanao.)

S. fasciatus Fisher.

d^2. Elytra dark violaceous or black, without blue reflections.

e^1. Elytra shining, with six (3 + 3) large spots on disk and with a short, humeral, elongate white spot formed of silvery white, silky pubescence. Head green, vertex black. Prothorax black with greenish sides, elytra black; 3.5 millimeters. (Basilan.) .... **S. delicatulus** sp. nov.

e^2. Elytra without isolated spots, elytral designs being formed of more or less distinct transverse flexuous and sinuate fasciæ.

f^1. Pronotum and elytra of the same color.

g^1. Pubescence on elytra forming a transverse row of four ring-shaped spots at apical fourth. Short, head bright cupreous, pronotum black, with violaceous reflection. Elytra black, basal half irregularly marked with white pubescence at apical fourth; 3.25 millimeters. (Luzon.)

S. luzonicus Fisher.

g^2. Pubescence on elytra forming a zigzag transverse band at apical third.

h^1. Pubescence on elytra silky white, without intermixed yellow hairs. Behind the transverse band at apical third of elytra with another solid transverse band.

i^1. Head deeply grooved on vertex and occiput. Entirely black, the white pilosity of elytra forming designs as follows: On basal half an irregular longitudinal band on median part and another along suture, there somewhat broken up and connected at basal fourth, a transverse zigzag band at apical fourth connected along suture and lateral margin to a straight transverse band at apical fifth; 5 millimeters. (Luzon.) .... **S. nigricans** Fisher.

i^2. Head very feebly grooved on vertex and occiput. Entirely black, with slight violaceous reflections, the white designs of elytra similar to those in *S. lugubris* E. Sd.; 4.5 millimeters. (Basilan.)

S. parisii H. Deyrolle.

h^2. Pubescence on elytra golden. White ornamentation on elytra less distinct, not forming a solid transverse apical band behind preapical zigzag band. Black, feebly shining, with feeble æneous reflections; entire surface covered with very fine, short, brownish golden pubescence. White ornamentation small and quite inconspicuous; 4 millimeters. (Borneo.)

S. bakerianus sp. nov.

f^2. Pronotum coppery or æneous; elytra black or violaceous.

g^1. Pubescence above consisting of white hairs. Rather robust, head and pronotum bright coppery bronze.

Elytra black and marked with transverse zigzag band. Head broadly grooved, the groove becoming deeper on vertex and occiput; 4 millimeters. (Luzon.)
S. aeneicollis Fisher.

*g*². Pubescence above consisting of yellow hairs or of yellow and white hairs intermixed.

*h*¹. Vertex with deep median impression, biconvex. The greatest width of prothorax behind the middle. Sides of front feebly but distinctly sinuate. Head and prothorax cupreous, elytra dark; 4.4 millimeters. (Luzon.) .... **S. maquilingi** sp. nov.

*h*². Vertex with slight median impression, convex. Greatest width of prothorax in or near the middle. Sides of front parallel.

*i*¹. Larger, more robust. Head and prothorax cupreous; front wider. Transverse elytral fasciæ more flexuous. Greater width of prothorax a little behind the middle; 4 to 4.5 millimeters. (Mindanao and Luzon.) .... **S. lugubris** E. Saunders.

*i*². Smaller, slender. Head bluish green, vertex and prothorax æneous, a little darker in the middle. Front narrower. Transverse elytral fasciæ less flexuous. Greatest width of prothorax in the middle, the latter with more flattened sides laterally; 3.4 millimeters. (Philippines.) .... **S. faustinus** sp. nov.

This rather homogeneous genus is represented in the palæarctic fauna by three species, in the oriental by fifty-six, in the Papuan by two, in Polynesia by two, and in the African by six known species. The species are rather difficult to determine, because they offer few sculptural characters, and the designs of the elytra and the coloring of the body are rather variable.

Sambus adonis sp. nov. Plate 1, fig. 22.

Capite ac thorace cupreo aurato, fronte splendide smaragdinea, thoracis lateribus leviter viridescentibus. Elytris cupreis, luteo-griseo pubescentibus, solum macula longa semiovali laterali, sicut apud *S. dives* H. Deyrolle formata glabra ac purpureo-violacea. Capite lato, oculis lateraliter leviter prominulis, fronte subparallela, latitudine paulo longiori, transverse rugosa, leviter, sparse luteogriseo pilosa. Vertice medio satis fortiter impresso. Thorace longitudine 2¼ latiori, medio convexo, ante basim transverse leviter late impresso, latitudinem maximam in medio longitudinis attingente, lateribus satis leviter rotundatis; carina laterali fere recta, haud forti. Superficie thoraci nitida, satis sparse strigoso-rugosa ac similiter quam caput pilosa. Elytris dense, minute granulosis,

haud nitidis, pube aequali ac densa ornatis, forma speciei *S. dives* simillibus. Corpore subtus aeneo, satis nitido, pedibus auratis ac nitidis.

Patria: Sulu Islands (coll. *Obenberger*). Long. 4.5 mm.

This species is very similar to *S. dives* E. Saunders and also to *S. pertoldi* from eastern India (Bombay), and can be distinguished from the former as follows: The color is more brilliant; the underface in *dives* is entirely black. The purplish lateral maculæ are narrower than in *dives* and the sutural hairy space between them is distinctly wider. Prothorax in *dives* is a little longer, having the greatest width behind the middle. Head of *adonis* is wider than in *dives*, with more prominent eyes. Body generally more robust. Color of legs entirely different, being dark æneous in *dives* and splendidly golden in *adonis*. Head and prothorax bright coppery golden, covered with a fine yellowish gray pilosity; front bright green, transversely rugose. Prothorax nearly 2.25 times wider than long, the greatest width in the middle, with gently rounded sides, fine, straight, lateral carina, entirely covered with sparse, fine pilosity, shining, surface with fine striation. Elytra similar to *dives;* namely, they are entirely covered with fine, dense pilosity; only laterally is there an elongate, half-oval, hairless, purplish violet vitta; other parts of elytra cupreous. The vitta is well defined and like the other surfaces finely, densely granulate, feebly shining. Below brassy, legs golden.

This is a representative of a separate and well-defined group in the genus *Sambus*. In my collection there is a single specimen of this beautiful species, from the old collection of Meyer-Darcis.

Sambus pertoldi, recently described from Bombay, is a similar species, but there the lateral maculæ are very indistinct and the size, pilosity, and form of head and prothorax are very different.

Sambus sandakanus sp. nov. Plate 1, fig. 18.

Olivaceo viridis, nitidus, thorace medio ac elytrorum disco leviter obscuratis; luteo pilosus. Capite lato, oculis lateraliter prominulis, fronte modice convexa, in medio transversim superbe cyaneo plagosa, transverse rugosa, longitudine paullo latiori, sparse aureopilosa. Thorace longitudine fere $2\frac{1}{2}$ latiore, lato, lateribus rotundatis, carina basali recta, disco subconvexo, ante basim transverse fortiter impresso, nitido, sparse, subtiliter transverse rugoso, sparsim ac tenuiter aureo piloso. Elytris

latitudine fere 2⅓ longioribus, lateribus usque ad tertiam partem apicalem subparallelis, dein ad apicem rotundatim attenuatis ac apicibus transverse subobtuse conjunctim rotundatis. Elytris satis dense granulosis, lateribus antice transverse rugosulis, macula minori postscutellari suturali, macula magna communi transversa postmediana ovali, maculaque minori praeapicali laterali paulo obscuratis ac nitidioribus, glabris, pilorum fasciis luteis postice ac antice cinctis. Fascia curta suturali postscutellari communi. Corpore subtus pedibusque griseis, nitidis, obscuris. Segmento abdominali primo medio leviter sulcato, segmento anali apice late sinuato; abdomine fere glabro, laevi.

Patria: Borneo, Sandakan (*Baker*). Long. 3 mm.

This species is remarkable by its color and the disposition of the elytral fasciæ. Olivaceous, shining, the middle of prothorax and the less densely granulate, hairless spaces or maculæ on elytra indistinct. Head rather broad, with laterally rather prominent eyes; middle of front adorned with a superb blue, transverse macula; front transversely rugose and equally finely covered with golden hairs. Thorax nearly 2.5 times as wide as long, with a long, strong, straight basal carina, with a strong transverse depression before base, this very fine laterally, sparsely rugose, rather shining, covered with equal, fine, sparse golden pubescence. Elytra rather short and rather depressed, with parallel sides to apical third, then finely, moderately rounded and attenuate to tip, where they are subobtuse and transversely, commonly rounded. Surface covered with yellow pilosity, not equally disposed, encircling in the form of denser fasciæ the hairless, obscure spaces, which are: First, behind base, small and near suture; second, common to both elytra behind the middle, large oval and transverse; third, before apices, placed laterally and small. Undersurface gray, with feeble olivaceous luster, shining, first abdominal segment in the middle with a longitudinal impression; last ventral segment broadly sinuate at tip.

Sambus philippinarum sp. nov. Plate 1, fig. 24.

Olivaceus, satis nitidus, satis robustus. Capite cupreo, convexo, fronte convexa, longitudine paullo latiore, vertice in medio haud impresso. Oculis lateraliter paullo prominulis. Antennis cyanescentibus. Thorace longitudine fere 2⅓ latiori, ante basim transverse late impresso, lateribus paulo depressis, carina laterali fere indistincta, latitudinem maximam paullo postmedium

attingente, lateribus rotundatis; colore aureo, satis nitido, superficie satis dense punctato-rugosa, ac, similiter quam caput, subtiliter luteo griseo pilosa. Elytris forma quam apud *S. lugubris* E. Saunders similiter instructis, sed paullo longioribus, satis nitidis, dense ac minute strigoso granulosis, ornamento fasciarum undulatarum satis latarum ac antice haud regularium luteo grisearum ornatis. Corpore subtus pedibusque aeneis.

Patria: "Philippines" (coll. *Obenberger*). Long. 5.3 mm.

Olivaceous, rather shining, rather robust, generally of the form of *S. lugubris* E. Saunders, but a little narrower. Head cupreous, convex, without median longitudinal impression, a little wider than long, eyes rather small and only feebly prominent on sides. Antennæ black with bluish tinge. Thorax nearly 2⅛ times wider than long, with a wide and feeble basal depression, with more distinct lateral impression on sides, the greatest width a little behind middle. Lateral carina nearly obsolete, sides rather strongly rounded. Thorax golden, surface with a rather dense, fine, punctulate striation, covered with fine, yellowish white pilosity. Elytra of a form similar to that in *S. lugubris*, only a little longer; they are densely and finely strigose-granulose, their surface covered with ornamentation generally resembling that of *lugubris*, but unicolored, formed of yellowish white hairs as on prothorax and anteriorly less distinct. Undersurface and legs brassy.

I have in my collection a single specimen of this species, from Staudinger and A. Bang-Haas, Dresden, but without more precise indication of locality.

Sambus delicatulus sp. nov. Plate 1, fig. 21.

Species pulcherrima. Capite smaragdineo, alutaceo, albo sparse piloso. Vertice nigro. Thorace nigro, nitido, fere glabro, lateribus viridimarginatis. Elytris nigris, glabris, utrimque maculis tribus albosericeis ac macula parva subhumerali laterali. Capite lato, oculis lateraliter satis prominulis, fronte ac vertice haud impresso, fronte lateribus parallelis, latitudine ⅕ longiore, plano, antennis viridibus. Thorace longitudine fere 2½ latiore, latitudinem maximam in medio attingente, lateribus satis fortiter rotundatis, carina laterali fere indistincta, ante basim late transverse, haud profunde impresso, superficie fere levi, in medio ante scutellum vitta brevi ac tenui longitudinali basali pilorum albosericeorum, superficie minutissime, sparse strigosa ac punctulata. Elytris latitudine 2½ longioribus, usque ad dimidium parallelis, dein ad apicem leviter rotundatim atte-

nuatis ac apice conjunctim rotundatis, post humeris lateraliter leviter impressis ac ibi macula parva albosericea ornatis. Maculis tribus elytrorum ut sequitur dispositis: prima rotunda, minori in parte tertia basali ac in latitudinis elytri medio, secunda transversa, subfasciformi in parte tertia apicali, suturam haud attingente, tertia parva obliqua in elytrorum apicibus posita. Corpore subtus nigro, pedibus aureoviridibus.

Patria: Basilan Island (*Baker*). Long. 3.5 mm.

This is one of the most beautiful species of the genus. Head shagreened, without median impression, green, wide, with laterally rather prominent eyes, and with sparse, white, fine, silky pilosity. Vertex black. Thorax black, only the sides greenish, with extremely fine, sparse striation and with very fine punctuation between, shining, nearly hairless, spaces only before scutellum with a short, narrow, longitudinal, basal vitta of silky white hairs; the greatest width in the middle, the sides rather strongly rounded. Elytra black, with three large silky white maculæ on each side and with a small lateral similar subhumeral macula. The maculæ are placed as follows: The first rounded, rather small, in basal third, in the middle of each elytron; the second in apical third, transverse, fasciform, wide, reaching lateral margin and interrupted on suture; the last oblique and placed on apex. Undersurface black, legs golden green. Elytra finely but not very densely strigose and rather shining.

In this collection were two specimens of this species. I know of no similar form with which to compare it.

Sambus bakerianus sp. nov. Plate 1, fig. 19.

Niger, subobscurus, unicolor, convexiusculus. Capite lato, subconvexo, vertice modice simpliceque canaliculato. Elytris subconvexis, dorso subdeplanatis, similiter quam caput et prothorax subtilissime dense breviterque aureopubescentibus; pubescentia illa huc et illuc densiore et in figuras aliquot nudiformes, alicubi minus distinctas disposita. Partes quae subglabrae apparent, pubescentia obscura et indistincta tectae sunt. In tertia parte anteriori in regione dorsali prope suturam macula minor, rotundata, punctiformis, in tertia parte apicali undula similis, angulosa, $\wedge$-formis positae sunt, his duo maculis e pubescentia subtili et densa, albida, sericea compositis. Sculptura elytrorum subtiliori in disco, ad partem lateroanteriorum subrugosa fortiori et squamulas indistinctas subtransversales efficiente. Subtus obscure aeneus, subnitidus, abdomine densis-

sime ac subtilissime punctato, apice integro. Segmento I° abdominali convexo. Scutello carinato.

Patria: Borneo, Sandakan (*Baker*). Long. 9 mm.

This species approaches species of the group of *vermiculatus* Deyrolle.

Black, feebly shining, with a feeble æneous luster on sides. Entire surface covered with a fine, dense, and generally not very distinct sculpture, because the greater part of the rugosities is covered by the very short and fine, brownish golden pubescence, which forms the ornamentation composed of a large sutural line and some quite indistinct transverse and undulate lines; the parts of the elytra that are less distinctly pubescent are covered with a darker, finer pubescence. These two types of pubescence are not distinctly separated from each other; in the first third occurs a small, very distinct, well-separated white point; a similar and narrow, angulate line occurs on hind third of length. Head convex, finely punctured, with a fine impressed line in the middle. Prothorax 2.5 times broader than long, anteriorly evenly cut off, regularly rounded on sides, broader basally than anteriorly, with a straight short carina on hind edges, and a moderate transverse impression before base. Antennæ and legs brassy; antennæ short, with short articles. Undersurface densely and regularly covered with a short, fine, golden pubescence.

I have named this species, of which I know only the type from Sandakan, Borneo, in honor of Charles Fuller Baker, who kindly sent it to me.

Sambus parisii H. Deyrolle.

A single specimen of this species, which resembles *S. lugubris* E. Saunders, was taken in Basilan Island (*Baker*).

Sambus lugubris E. Saunders.

A species of wide distribution in the Philippine Islands. In this collection there were specimens from Kolambugan and Dapitan, Mindanao. The species is rather variable in size, and in the more or less pronounced elytral fasciæ which vary also in width and color.

Sambus maquilingi sp. nov. Plate 1, fig. 20.

Capite thoraceque cupreis, elytris obscuris, corpore subtus nigroviridi, brevissime albopiloso. Capite satis convexo, fronte

viridescente, latitudine paulo longiore, vertice profunde longitudinaliter impresso, oculis lateraliter haud prominulis; fronte aureopilosa. Antennis brevibus, nigris. Thorace latitudinem maximam post medium, prope tertiam partem basalem attingente, lateribus fortiter rotundatis; disco convexo; impressione forti praebasali transversa; carinis lateralibus fortibus ac arcuatis; thoracis superficie satis dense ac minute granuloso rugosa, aureopilosa. Elytris dense ac minute granulosis, obscure nigroviolaceis, parum nitidis, fascia satis indistincta postscutellari, fasciis duobus ante medium approximatis, distinctioribus ac magis flexuosis, dein fasciis duobus praeapicalibus valde flexuosis aureopilosis ornatis. Apicibus elytrorum pilis aliquot albidis ornatis. Elytris subconvexis, lateribus usque ad tertiam partem apicalem parallelis, dein ad apicem rotundatim attenuatis ac conjunctim rotundatis. Corpore subtus dense granuloso, pedibus obscuris. Segmento abdominali primo ac ultimo integris.

Patria: Luzon, Mount Maquiling (*Baker*). Long. 4.4 mm.

This species is rather similar to *S. lugubris* E. Saunders but differs from that species by many characters. Vertex less convex, but with deeper median impression; prothorax less wide and with more rotundate sides; elytra less robust, with denser, finer granulation; fasciæ of elytra wider and unicolored golden. Head and prothorax cupreous; elytra obscured, nearly black, with very feeble violaceous luster. Head rather convex; front a little longer than wide, vertex deeply longitudinally impressed in the middle. Antennæ short and black. Eyes not prominent laterally. Prothorax rather wide, the greatest width behind the middle, nearly at basal third; with deep transverse basal impression. Disk rather convex; the lateral carinæ strong, curved, and rather long. Surface of prothorax densely, rather finely rugose, and only very feebly shining, covered with short, sparse golden pilosity, similar to that of head. Elytra similar in form to *lugubris,* densely covered with rather fine granulation, adorned with the following flexuous, transverse fasciæ of golden hairs: First, rather indistinct, behind base; second and third, before the middle; and fourth and fifth, behind the middle, the latter more flexuous than the others. Undersurface dark, granulate, rather feebly shining, the first and last abdominal segments without peculiar characters.

A single specimen of this remarkable species is in the Baker collection.

Sambus faustinus sp. nov. Plate 1, fig. 23.

Speciei *S. lugubris* E. Saunders simillimus, sed ab eo uti sequitur, valde divergens. Corpore minus robusto, minus lato. Capite minus convexo, fronte minus lata ac paullo longiore, oculis lateraliter minus prominulis. Capite thoraceque aeneo, satis nitido, thorace lateribus multo minus rotundatis, in medio latitudinem maximam attingente. Carina laterali thoracis distinctiore. Elytris minus latis quam apud *S. lugubris*, obscure aeneo-violaceis, ornamentis similiter quam apud *S. lugubris* ornatis; fasciis his partim e luteis, partim ex. albidis pilis compositis. Gulari processa ac segmento anali similiter quam apud *S. lugubris* formatis. Vertice multo minus fortiter impresso; corporis sculptura simili, sed thorace plus piloso ac subtilius strigoso.

Patria: "Philippinas" (coll. *Obenberger*). Long. 3.4 mm.

This species, represented in my collection by a single specimen, was purchased from Staudinger and Bang-Haas, but without exact indication of locality. It resembles very much *S. lugubris* E. Saunders and is generally similar in size and ornamentation. Less robust, a little more elongate; head less wide, front narrower. Vertex much less strongly impressed in the middle. Eyes less prominent laterally and also a little smaller. Thorax less robust, the greatest width in the middle, and of brassy color. Lateral carina of prothorax more distinct. General sculpture similar, but the surface of thorax more finely strigose and covered with a denser gray pilosity. Elytra longer and narrower than in *lugubris*, of a dark brassy violaceous color, with similar hairy fasciæ as in *lugubris;* fasciæ yellow and white.

Genus **MELIBOEUS** H. Deyrolle

The species of this genus are rather numerous in the Palæartic and African faunæ; in the Oriental fauna, on the continent, they are also rather numerous, though still little known; they seem to be rare on the large Oriental islands.

I have found in the Baker collection three new species of this very difficult genus, one of which, already represented in my own collection and designated as new, inhabits Kinabalu.

The genus *Nalanda* Thery perhaps falls into synonymy with the old *Meliboeus,* as the characters of the elytral sculpture are very variable in this genus, in which it is possible to find all

conditions from the pure *Meliboeus* type (*Meliboeus bisetus* Thunberg) to the *Nalanda* type. *Nalanda* was based on a species from Ceylon.

Meliboeus carbonicolor sp. nov. Plate 1, fig. 16.

Parvus, nitidus, corpore toto nigro, glabro. Capite subconvexo, subpunctura normali minutissime alutaceo, toto obscure cuprescente, sine linea media frontali. Oculis desuper observatis parvis, lateraliter non prominentibus partem anteriorem thoracis attingentibus. Thorace longitudine 1½ latiori, nitido, convexo, dense reticulato-punctulato, impressione transversa et obliqua basali ornato. Margine laterali in parte basali modeste subsinuata. Sculptura thoracali e rugis distinctis rotundatis et dense punctatis composita; scutello parvo, triangulari, longitudine paulo latiore. Elytris subconvexis, latitudine 2½ longioribus, ante medium paulo attenuatis, apicibus rotundatis, parte posteriori superficiei subdepressa, illic sutura elevata. Sculptura e seriis transversalibus punctorum composita; scilicet punctorum partem anteriorum transversaliter cum parte anteriore punctorum vicinorum confluente et eo rugam hanc caracteristicam efficiente, quae apud species copiosas imprimis regionis orientalis descripta est; qua de causa tota coleopterorum superficies transversaliter rugata esse videtur; his "rugis" latioribus.

Patria: Borneo, Sandakan (*Baker*); Kinabalu (coll. *Obenberger*). Long. 3.8–4 mm.

This species is represented by a specimen from Kinabalu in my collection. It is related to *Meliboeus stupidus* Obenberger, *M. substituens* Obenberger, and *M. aeneifrons* H. Deyrolle. It is of the same color, but is less convex; the head surface is without shagreening or microscopical rugosity; the front is rugose and not with simple puncturation. The thorax of Deyrolle's species is more rugose and less convex. In *M. carbonicolor* the basal impression is deeper and larger; the thorax is laterally more conical, larger, and laterally rounded as in *aenifrons.*

A single specimen from Sandakan, Borneo, occurs in the Baker material, and another specimen, from Kinabalu, Borneo, in my own collection.

Meliboeus pravus sp. nov. Plate 1, fig. 15.

Parvus, nitidus, corpore glabriusculo; abdomine et partibus corporis inferioribus obscure aeneis, nitidis, fronte viridiaenea,

prothorace nigro, lateribus prothoracis tenue viridiaeneo emarginatis. Coleopteris nigrocoeruleis, nitidis, apice violascentibus. Haec species parva sculptura et forma corporis speciei praecedenti simillima; a specie illa fronte latiore (qui apud specium praecedentem latior est transversalis oculi singuli latitudinis) apud speciem praesentem haec dimensiones fere aequales sunt discrepat; desuper observata pars ocularum lateralis maior est apud speciem praesentem quam apud *M. carbonicolorem* sp. nov.; sculptura thoracis fortiori, sculptum coleopterorum minus densa. Corpore speciei praesentis etiam paulo abbreviato et dilatato.

Patria: Borneo, Sandakan (*Baker*). Long. 3.5 mm.

This species is related to the preceding species. The body is generally similar, but a little more enlarged. The elements of the sculpture of the elytra are similar. The lateral sinuation of the hind margin of prothorax is less developed. The most important difference between the two species is in the form of the front; this is larger than in *M. carbonicolor,* laterally parallel; the eyes are smaller, their breadth (transverse diameter) less than the breadth of the front between the eyes. In the present species the eyes are larger, the transverse diameter of an eye is equal to distance between the eyes (in the middle of front). The front is not parallel-sided, but attenuate, and laterally a little rounded; therefore, the least breadth of the front is behind and not on the epistome.

A single specimen from Sandakan, Borneo (*Baker*).

Meliboeus dapitanus sp. nov. Plate 1, fig. 17.

Niger, glaber, nitidus, elytris subviolascentibus. Thorace capiteque obscure roseocupreo. Capite (desuper observato) subconico, oculis perparum visibilibus, fronte ad anticem concave attenuata, lateribus subrotundatis; antice subparallelis, fronte longitudine (ab antennarum cavitatibus usque ad verticem) fere 1½ longiore, transverse rugosa, glabrata, sine impressione media cavitatibus antennarum approximatis, epistomate ea de re fortiter attenuato. Thorace in medio circiter latitudinem maximam attingente, dein ad basim leviter, antice fortius rotundato-attenuato, in medio leviter subgibboso, depressione transversa praebasali, satis dense ac transverse rugoso, rugis singulis distincte punctatis. Scutello lato ac parvo. Elytris glabratis, antice distinctius rugosis, nitidis, convexis, hume-

ris haud prominulis. Abdomine pedibusque nigris, nitidis, processu prosternali parallelo, segmento anali apice subtruncato.

Patria: Dapitan, Mindanao (*Baker*). Long. 3.5 mm.

This species resembles very much the two other species described here and can be easily distinguished from them by the more conical form of the head, the less-developed eyes, and the pronotum having the greatest width nearly in the middle and being more strongly rounded anteriorly.

Black, rather shining, on the elytra with a slight violaceous luster. Head and prothorax dark coppery color. Head relatively small, front narrow, attenuate, then nearly parallel anteriorly. Thorax subgibbose in the middle, the greatest width nearly in the middle, with a large transverse depression before base, with fine, sharp rugation, the rugæ distinctly punctured. Antennæ short and black. Form and sculpture of elytra as in the other two species described here. Prosternal process parallel-sided; abdomen black and shining; last ventral segment subtruncate at apex.

The species of this group are very difficult to distinguish from one another. The general characters of the group are small size, glabrous elytra, and peculiar rugosity of prothorax and elytra. The rugæ are here covered with regular, short, linear punctures. In my opinion the genus *Nalanda*, described by A. Thery, also forms part of this group of *Meliboeus*. The group has many intermediate forms, grading into the general type of *Meliboeus* as it occurs in southern Africa.

Genus **AGRILUS** Stephens

Agrilus is the largest genus of the Buprestidæ and one of the most important in that family. It contains to-day about 1,200 described species, but this number probably represents only a small part of the existing species. In my own collection there are at least 400 undescribed new species, from South America, Africa, and the Oriental Region. Most of the species of this genus are of small size, rather elongate, and narrowed.

Head more or less convex; eyes more or less prominent laterally or rounded. Antennæ dentate from fourth or fifth joint; the triangular joints often widened, sometimes very transverse; sometimes the antennæ are sexually dimorphic (*A. laticornis* Illiger or *A. dimorphus* M.). Vertex sometimes more or less deeply longitudinally impressed, sometimes very convex.

The form of the lateral margins of the front or of the eyes is of great systematic importance; some species have the front with parallel sides, but in many forms these margins are sinuate. This character has not been given enough attention. It is, however, rather difficult to found sections on it, because the form of the front is sometimes sexually variable, and also because it has not been described for some of the commonest species; for example, the male of the common North American *Agrilus bilineatus* Randall has the front more narrowed, with sinuate sides, while the female has the front very distinctly wider and shorter anteriorly with nearly parallel sides; in the common European *Agrilus elongatus* Hb. (*tenuis* Rtzb.) the males also have the sides of the front sinuate, but the females are nearly parallel-sided, where the front is wider than in the male. This sexual variation has not, so far as I know, been mentioned in the literature.

Prothoracic characters are very important in *Agrilus*. There is a lateral margin, which is acute and forms a carina (lateral carina or marginal carina) ; this is rather variable, straight or sinuate. Under this carina there is another, more or less arcuate, long carina (submarginal carina), which joins the lateral carina at or in front of the hind angles. At the hind angles there is a third carina (prehumeral carina), which is called lateral carina by some authors; it is more or less strong, more or less developed, convex or nearly straight, short or elongate, sometimes approaching the marginal carina at middle, and distinct also in anterior part of prothorax. Disk of pronotum convex or more or less uneven; prosternum anteriorly margined by a more or less developed gular lobe, processus gularis, or prosternal lobe; this is rounded or sinuate (emarginate) in front, a very important character, and both modifications can be observed in species from all parts of the world. The form of prosternal process is also sometimes of great importance, but it varies rather strongly in some species, and very often is difficult to observe, because the dead Agrili have the legs folded over it in most cases and they cannot always be reprepared. Sexual dimorphism is here also well marked; in some species the prosternal process in the male is covered with a fine, silky white pilosity, and in the female it is nearly hairless. Scutellum more or less transverse, with a transverse carina, in rare cases without it. Elytra acuminate, bidentate, or rounded apically, some-

times (species of southern America) widely enlarged and spatuliform apically.

The length and width of elytra are constant. Elytra rather flattened above, or convex, sometimes with elevated suture posteriorly. In some cases the space along the suture is rather depressed; in some American and African species this suture is extensively marked with an elongate costa. I know no such species in the Oriental fauna. The elytra are generally somewhat hairy; when seemingly hairless the elytra are in reality covered with a very fine, inconspicuous, nearly invisible, dark blackish pilosity. The elytral pubescence, when mentioned in the descriptions, is always described as pale, white or yellowish, in some cases testaceous or brownish, rarely intermixed. The arrangement of the pilosity is very important in this genus. It varies slightly and can be employed very well in tabular analysis. The following systems of arrangement of pilosity on the elytra of diverse Agrili can be distinguished:

1. Pilosity equal. The hairs evenly distributed at equal distances from one another, not condensed along suture. In some Oriental species of this group the pilosity is rather indistinct laterally on the declivate sides.
2. Pilosity equal along suture; indistinct laterally, forming a longitudinal fascia along suture on the unimpressed surface. The space along suture is not sulciform. Here belong some African species of this genus.
3. Pilosity rather equal; in or near apical third interrupted by a hairless, glabrous, sometimes darkened oval or transverse fascia. Sometimes the pilosity of apical part is a little condensed on suture. This group is widely distributed in the Palæarctic (*A. graminis* C. G.) and Oriental Regions. It is very rare in South America and in the African fauna. The females of some species have the hairless transverse band rather indistinct, and can be easily mistaken for some representatives of the first group.
4. Surface of elytra pilose, the pilosity condensed along suture in a more or less distinct vitta. There may be some modifications, as follows:
   a. The vitta very distinct, dense, on sulciform surface.
   b. The vitta rather inconspicuous, only indicated. The species of this group may in some cases be considered as belonging to the first group.
   c. The vitta a little sinuate, being posteriorly closer to suture. These three groups have representatives in the Oriental fauna. The third one is known only from Oriental regions.
5. Pilosity disposed on the elytra in diverse designs. There may be such modifications as the following:
   a. Pilosity combined bicolored or tricolored. Very rare species (*A. harlequin* sp. nov.).

b. Pilosity unicolored, fasciform, on unicolored surface.
c. Pilosity unicolored, forming diverse designs, not fasciform, on unicolored surface.
d. Pilosity unicolored, and forming fasciæ or designs on diversely colored surface.

6. Pilosity equal anteriorly and posteriorly; the remaining surface glabrous, sometimes otherwise colored. Here belong some African and Oriental species.
7. Pilosity disposed in isolated maculæ. There may be modifications as follows:
   a. Two spots (white, yellow, or brown) (1 + 1) along suture.
   b. Four spots (2 + 2) along suture.
   c. Six spots (3 +3) along suture.
   d. Eight spots (4 + 4) along suture.
   e. More than eight spots (5 + 5, 6 + 6) along suture.
   f. A great number of little spots (*A. occipitalis* Eschscholtz).
   g. The spots diversely disposed, not only along suture, in various numbers.

In some cases in apparently hairless species there is an indistinct elongate spot on each side of suture apically. Nearly all combinations mentioned here are known from the Oriental Region. The maculæ, or spots, are always unicolored; it is only in a group from southern Africa (*Agrilus sexguttatus* Herbst, *A. andresi* Obenberger, etc.) that the spots are bicolored, testaceous or white anteriorly, black posteriorly. Elytral sculpture composed of a rather rough squamuliform granulation; in some cases this granulation is very fine and dense (*cyaneoniger* E. Saunders, *marquardti* Obenberger, *lanceyi* Obenberger, *splendidicollis* Fairmaire, *mikado* M., *ataman* Obenberger, *auristernum* M., *spinipennis* Lewis, etc., all from the Oriental and eastern Palæarctic Regions).

In some Oriental species there is developed a straight, more or less long humeral elytral carina. This carina forms a prolongation of the prothoracic prehumeral carina and is systematically very important, and not variable. The abdomen is more or less convex; in some cases the dorsolateral part of the first two abdominal sternites is not covered by the elytra; there is here often a lateral pilose spot or sometimes a depression. Where such depression exists, the cariniform lateral margin of the abdomen is broadly sinuate and furnishes very good characters for systematic study. The tergites of the abdomen (the upper face of the abdomen, covered by the elytra) is in most cases bright blue, golden, or green; the last is in most cases longitudinally carinate in the middle; in some species this carina (regularly covered by

the elytra) is prolonged at the tip in a more or less long process distinctly visible from above between the tips of the elytra. It is a very good systematic character, neglected in most cases by the older authors.

The sides of the abdomen (often also the mesosternum and the metasternum) are sometimes covered with more or less distinct spots or maculæ. The last ventral segment is either rounded or sinuate or emarginate at tip. The emargination is large, sinuate, or short, with acute sides, and is in reality formed in some cases not by the external margin of this segment, but by a very fine premarginal stria. The species with sinuate anal segment occur rather commonly in the Palæarctic and Oriental Regions. Among my 250 African species I know of but one that has the last ventral segment sinuate. All North American and Neotropical species have the anal segment rounded at the tip.

On the first abdominal segment there are often some sexual markings. In a group, represented in Europe and in the Oriental Region, there are two small approximate granulæ in the middle in males, sometimes only one; in a large American group the males are adorned there by a fine longitudinal (sometimes impressed) vitta, composed of a silky white pilosity. The last ventral segment in the male is sometimes impressed in the middle. The feet offer very good characters. The length of the first joint of the posterior tarsi is normally constant, in comparison with the other joints and with the length of the tibia. Also, the mucronation of the hind tibiæ (on the inner apical side) may be important. The hind femora in some cases are enlarged.

A useful character is found in the form of the claws; these are either simply cleft, or cleft in such a manner that the lower portions are turned inward and nearly touch. This character cannot be employed for the making of groups, as was done in Horn's key to North American species, because it is rather variable and offers all stages from one type to the other. It is also one of the most inconvenient and obscure characters and is best avoided in making keys. It can, however, be employed very well to distinguish species.

The form of genitalia of the male was formerly never mentioned in the Buprestidæ, though it is rather important. In the Agrili of the Oriental Region, usually, the parameræ of the penis are diagnostic among the species; in a few cases the ædeagus also offers good markings; it is regularly acuminate, in some cases truncate, and emarginate at tip.

Key to the species of Agrilus Stephens.[2]

a^1. Elytra spinose at tip.

b^1. Elytra unispinose at tip.[6]

c^1. Tip of elytron acuminate, spine at middle of apex.

d^1. Pygidium with projecting carina at tip.

e^1. Elytra covered with rather equal, fine, pale pilosity, with a dark, hairless, preapical, transverse band.

f^1. Larger. Prothorax parallel on sides. Elytra dark, bluish, elytral pilosity yellow. Mesosternal pilosity and laterodorsal macula on sides of elytra golden; 7.5 millimeters. (Kinabalu.) .... **A. croceisquamis sp. nov.**

f^2. Smaller. Prothorax distinctly narrowed to base. Elytra bronzy green, covered with paler pilosity. Mesosternal pilosity and laterodorsal macula at sides of elytra silky white; 5.4 to 6.5 millimeters. (Borneo.)

A. pictithorax sp. nov.

e^2. Elytra with six (3 + 3) pubescent areas. Elongate, parallel; front of head and margin of pronotum green; vertex, pronotum except margin, and elytra black; 6.25 to 8 millimeters. (Luzon and Palawan.) .... **A. sexsignatus Fisher.**

e^3. Elytra without distinct pubescent areas, covered with short, dark, inconspicuous, recumbent hairs, not concealing the surface sculpture.

f^1. Uniformly dark green, elytra on suture, behind the middle with a poorly indicated gray macula on each side. Last ventral segment with a small, short, but very distinct incision at tip; 5 millimeters. (Singapore.)

A. tristinus sp. nov.

d^2. Pygidium without projecting carina at tip. Prosternal lobe emarginate, last ventral segment rounded at tip.

e^1. Front of head cupreous, sides of pronotum and beneath bright æneous with a strong cupreous reflection; occiput, prosternum, legs, disk of pronotum, and base of elytra dull dark green with a slight purplish tinge, the elytra becoming dark violaceous posteriorly and ornamented with two (four) pubescent areas, one at the middle and the other on apical third; 11 millimeters. (Mindanao.)

A. quadriplagiatus Fisher.

e^2. Front of head cupreous; sides of pronotum and beneath golden with cupreous tinge; occiput, pronotum, and elytra dark green, elytra becoming a little darker posteriorly, very densely and finely sculptured, without any ornamentation; 7 millimeters. (Kinabalu, Borneo.) .... **A. spinellifer sp. nov.**

c^2. Tip of elytron emarginate, spine on outer angle, sometimes with a very minute spine on sutural angle.

[2] The following, rather poorly described species are not included here: *abdominalis* E. Sd., *aequicollis* Eschsch., *atomus* Kerr., *balnearis* Kerr., *fontanus* Kerr., *pilicauda* E. Sd., *rubrifrons* H. Deyr. *semperi* E. Sd., *striaticollis* Kerr., *vilis* E. Sd., *oreophilus* Fisher (= *monticola* Kerr.).

[6] See also *Agrilus xenius* sp. nov.

d^1. Claws cleft in such a manner that the lower portion is turned inward or quite touches that of opposite side. Prosternal lobe rounded in front.

e^1. Pygidium with projecting carina at tip. Obscure, densely and very finely granulate, dark greenish, with a strong purplish tinge. A small white preapical spot on both sides of suture of elytra. Front purplish; 10 millimeters. (Singapore.) **A. purpurifrons** H. Deyrolle.

e^2. Pygidium without projecting carina at tip. The sculpture less dense, surface more shining.

f^1. Apical tooth of elytra stronger and longer without little teeth on outer side. A post-median and a preapical transverse white fascia (rather indistinct sometimes) on elytra; 8 millimeters, more or less. (Sumatra, Borneo, Java, Celebes, eastern India (?), and Philippines.)

g^1. Bright blue .... **A. acutus** Thunberg.

g^2. Surface black, underside blue. **A. acutus** var. **asphaltipennis** var. nov.

f^2. Apical tooth of elytra shorter, with some very fine, small teeth on outer side. Form less robust.

g^1. Above bright blue; 8.5 millimeters. (Luzon.) **A. piperi** Fisher.

g^2. Above green or bronzy green; 6.5 to 7 millimeters. (Luzon.) .... **A. luzonicus** Kerr.

d^2. Claws simply cleft, the lower portion not inverted. Disk with an ornamentation consisting of white, very flexuous transverse fasciæ on elytra; 8 to 10 millimeters. (New Guinea; Philippines: Mindanao and Palawan.) .... **A. ornatus** H. Deyrolle.

b^2. Elytra bispinose at tip.

c^1. Pygidium with projecting carina at tip.

d^1. Elytra without preapical, hairless, dark transverse band or macula.

e^1. Larger. Underside golden green. Prosternal (gular) lobe rounded, with a small granuliform elevation in the middle (male), last ventral segment emarginate at tip. An indistinct white longitudinal apical vitta along suture on each elytron; 9 millimeters. (Borneo.) .... **A. dajakorum** sp. nov.

e^2. Smaller. Elytra covered with equal, fine, yellow pubescence. Last ventral segment rounded at tip; 5 to 6.5 millimeters. (Borneo.) .... **A. insularis** H. Deyrolle.

d^2. Elytra covered with fine pilosity; behind the middle with a transverse, denuded, sometimes darkened band, or at least with a similar rounded macula at the same place.

e^1. With very distinct, dark, wide, transverse, preapical denudate band. Remaining surface of elytra less densely pilose.

f^1. Prothorax cupreous. Prosternal lobe and anal segment emarginate. Front (from antennal cavities) $1\frac{3}{7}$ times as long as wide, with parallel sides. Shorter; 5.7 millimeters. (Borneo.) .... **A. albogaster** H. Deyrolle.

f^2. Prothorax æneous or dark, nearly black. Of greater length.

g^1. Head less convex; front narrower, more sinuate at sides. Prothorax shorter, green or æneous, unicolored, lateral carina straight, prehumeral carina more convex; submarginal carina more convergent toward base and joining lateral carina before base. Gular prosternal lobe distinctly emarginate. Scutellum longer; 6 millimeters. (Philippines.) .... **A. saundersianus sp. nov.**

g^2. Head more convex, front distinctly wider, nearly parallel on sides. Prothorax longer, black, with green lateral margins. Lateral carina a little sinuate, prehumeral carina less convex, submarginal carina joined with lateral carina in basal angles. Gular (prosternal) lobe rounded. Scutellum shorter; 6 millimeters. (Philippines.)
A. nigrocinctus E. Saunders.

e^2. The hairless postmedian space on suture less distinct, of the same color as the remaining surface. Elytral pilosity more equal, denser, and longer. Gular (prosternal) lobe and anal segment emarginate.

f^1. More elongate. The hairless macula smaller. Front much narrower, a little sinuate on sides; prehumeral carina of prothorax longer and stronger. Prothorax longer, with parallel sides. Scutellum larger. Apical spines of elytra stronger and longer; 6 millimeters. (Philippines.)
A. inquinatus E. Saunders.

f^2. Shorter. The hairless macula larger. Front much wider, with nearly parallel sides. Prehumeral carina of prothorax shorter and less elevated. Prothorax shorter with less prominent median lobe on anterior margin, distinctly narrowed to base. Scutellum smaller. Apical spines of elytra shorter and smaller; 5.5 millimeters. (Borneo.)
A. simillipictus sp. nov.

c^2. Pygidium without projecting carina at tip.

d^1. Elytra with pubescent ornamentation. Head and sides of pronotum æneous, becoming purpureous toward apex. Each elytron with an inconspicuous wide band of short pubescence; 7.25 millimeters. (Mindanao and Luzon.)
A. subspinosus Fisher.

d^2. Elytra without distinct pubescent ornamentation, with an equal pilosity or nearly hairless.

e^1. Prothorax and head golden, elytra blue, covered with fine, equal, golden pilosity. Anal segment rounded at tip. Gular lobe rounded anteriorly; 5 millimeters. (Borneo.)
A. aureocoerulans sp. nov.

e^2. Color otherwise.

f^1. Prothoracic carina short, very arcuate, elytral spines unequal, blue. Hind tarsi nearly half as long as tibiæ, first joint about equal in length to the four following joints united; 8 millimeters. (Luzon.) .... **A. banahaoensis** Fisher.

*f*². Prothoracic carina longer, less arcuate.

*g*¹. Color dark violaceous, with bronzy humeral impressions on elytra. Hind tarsi nearly as long as tibiæ, first joint about equal in length to the three following joints united; 5.5 millimeters. (Singapore.) .... **A. falsulus sp. nov.**

*g*². Color bronzy or bronzy green. Surface covered with fine white pubescence.

*h*¹. Prehumeral carina of prothorax long, nearly straight, extending to lateral margin near middle. Intervals between strigæ of prothorax finely and sparsely punctate. Prosternal lobe acutely and rather deeply emarginate at middle; 6 millimeters. (Luzon.)
A. maquilingensis Fisher.

*h*². Prehumeral carina long, strongly approaching lateral carina (lateral margins). Intervals between strigæ of prothorax without minute puncturation. Prosternal lobe rounded; 3.9 millimeters. (Borneo.)
A. bidentellus sp. nov.

*h*³. Prehumeral carina rather feeble, long; prothorax rather long, without more distinct puncturation between strigæ. Prosternal lobe rather widely emarginate; 3.5 millimeters. (Philippines.) .... **A. intrusus sp. nov.**

*a*². Elytra not spinose at tip, more or less widely rounded, sometimes strongly dentate apically (exception, *A. xenius* sp. nov.).

*b*¹. Claws cleft in such a manner that the lower portion is turned inward, nearly or quite touching that of opposite side.

*c*¹. Hind angles of pronotum with distinct prehumeral carina.[4]

*d*¹. Hind tarsi half as long as tibiæ. Form elongate. Anal segment sinuate at tip. Apical third of elytra black and nearly glabrous, with the exception of an elongate sutural white vitta.

*e*¹. Larger. Front wider and shorter, with more-parallel sides. Eyes not so near together at occiput. Gular lobe distinctly sinuate. First joint of posterior tarsi as long as the two following joints united; 6 millimeters. (Mindanao and Luzon.) .... **A. kheili sp. nov.**

*e*². Smaller. Front longer and narrower, with more-sinuate sides. Eyes rather near together at occiput. Gular lobe rounded anteriorly. (Sumatra, Borneo, and Philippines.)
A. discicollis H. Deyrolle.

*d*². Hind tarsi not half as long as tibiæ. Form shorter, more robust. Apical third of elytra concolorous.

*e*¹. Intercoxal process elevated along sides. Front of head and beneath æneous; occiput, pronotum, and elytra greenish blue, with a strong violaceous tinge. Elytra sparsely clothed with short inconspicuous hairs, and each elytron with a transverse band of white pubescence at apical third and a similar band at tip; 5 millimeters. (Mindanao.) ..... **A. albocinctus Fisher.**

[4] Here should be placed also *Agrilus occipitalis* Eschsch., which I do not know in nature.

e^2. Intercoxal process not elevated along sides.

f^1. Rather robust, small; of a gray æneous color, the elytra equally clothed with recumbent, fine, white pilosity. Gular lobe rounded anteriorly; anal segment with a small but very distinct, sharp apical incision; 4 millimeters. (Borneo.) .... **A. agrestis** H. Deyrolle.

f^2. Rather robust, less convex. Elytra with a preapical transverse band, with an apical macula and with some maculæ on anterior half. Of a bluish green, rather dark color. Gular lobe rounded anteriorly, anal segment rounded at tip; 5.5 to 6 millimeters. (Borneo and Sumatra.)
A. gratiosus H. Deyrolle.

c^2. Hind angles of pronotum not carinate.

d^1. Hind femora much stronger and more robust than the anterior ones, distinctly dilated.

e^1. Above, blue to greenish blue. Front without smooth spaces. Elytra without rather indistinct inconspicuous pilosity; only behind in sutural region with a few yellow hairs; 5.5 to 6 millimeters. (Mindanao and Luzon.)
A. subpubescens Fisher.

e^2. Head and pronotum green, elytra brown with a strong æneous tinge. Front with two small smooth spaces anteriorly; 4 to 5 millimeters. (Mindanao.) ..... **A. zamboangensis** Fisher.

d^2. Hind femora not dilated.

e^1. Elytra with pubescent spaces.

f^1. Pubescence on elytra forming an inconspicuous vitta. Gular lobe rounded anteriorly, anal segment feebly sinuate at tip. Of a cupreous color; head dark green. Undersurface clothed with very short, very dense, white pilosity; 5.75 to 7 millimeters. (Mindanao, Luzon, and Palawan.)
A. inconstans Fisher.

f^2. Pubescence on elytra forming spots.

g^1. Blue. Tip of elytron broadly rounded and dentate, each elytron with the tip and a round spot near suture at apical third of short white pubescence; 8 millimeters. (Luzon.) .... **A. bakeri** Kerremans.

e^2. Elytra without pubescent spaces.

h^1. Above, bluish green. Prosternal lobe broadly truncate in front, anal segment broadly rounded at tip; 7 millimeters. (Mindanao and Luzon.) **A. subviridis** Fisher.

h^2. Color above cupreous to bronzy (rubbed specimens).
A. inconstans Fisher.

b^2. Claws simply cleft.

c^1. Hind angles of pronotum not carinate.

d^1. Intercoxal process gradually narrowing, tip acute.

e^1. Prosternal (gular) lobe arcuately emarginate in front.

f^1. Anal segment rounded at tip.

g^1. Color above green, shining, darkened along suture and near apex. Without traces of pale pilosity, the male with a single small granule in the middle of first segment; 6 millimeters. (Sulu Islands.) ..... **A. viridicolor** sp. nov.

g^2. Elytra with distinct pale, fine, short silky hairs.

h^1. The hairs forming a rather indistinct longitudinal narrow fascia along suture. Green. Male with a sharp tooth at middle of first abdominal segment. Larger; sides of pronotum nearly parallel. Rather shining; 6.75 to 8 millimeters. (Mindanao.)
A. subvittatus Fisher.

h^2. The hairs covering rather unequally the entire surface of elytra. Smaller; prothorax finely but roughly granulate, rounded on sides; 6 millimeters. (Sulu Islands.) .... **A. orientis** sp. nov.

f^2. Anal segment sinuate at tip. Elongate, rather narrowed, black; 5.8 millimeters. (Sulu Islands.)
A. encaustus sp. nov.

e^2. Prosternal (gular) lobe rounded in front. Anal segment rounded at tip. A distinct golden longitudinal fascia on elytra along suture. Head and pronotum brassy green, elytra green with purplish tinge; 5.25 to 6.8 millimeters. (Luzon and Mindanao.) (*A. fulvovittatus* Fisher.)
A. fisheri sp. nov.

d^2. Intercoxal process expanded behind coxæ, tip broad and emarginate. Uniformly olivaceous, the elytra rather densely clothed with short, semierect white hairs which form a wide inconspicuous band along suture; 6.5 millimeters. (Mindanao.)
A. semipubescens Fisher.

c^2. Hind angles of pronotum carinate (= prehumeral carina).

d^1. Pygidium with projecting carina at tip. Elongate, color uniformly plumbeous, with a slight purplish green tinge, front cupreous. Elytra rather densely clothed with distinct, short, whitish, recumbent hairs. Prosternal (gular) lobe broadly rounded in front, last ventral segment subtruncate at tip; 5.25 millimeters. (Mindanao.) .... **A. innotatus Fisher.**

d^2. Pygidium without projecting carina.

e^1. Upper surface clothed with combined pilosity, white and brown, with intermixed black hairs. Ornamentation resembling that of some *Sambus* species. Prosternal lobe rounded, last ventral segment subtruncate; 4.5 millimeters. (Kinabalu, Borneo.) .... **A. harlequin** sp. nov.

e^2. The pilosity (when present) unicolorous.

f^1. Elytra without longtudinal carina on humeri, forming the prolongation of the prehumeral carina of prothorax.

g^1. The white, gray, or yellow pilosity of elytra forms diverse distinct ornamentations, maculæ, fasciæ, or spots.

h^1. Last ventral segment rounded at tip.

i^1. Prosternal (gular) lobe rounded. Uniformly cupreous. Elytra with a postscutellar pubescent area; each elytron with a small spot of pale yellowish pubescence near suture and on apical third; 6.5 millimeters. (Palawan.) .... **A. palawanensis Fisher.**

i^2. Prosternal (gular) lobe distinctly emarginate. Four (2 + 2) small, elongate, pubescent areas along suture, situated in basal and in apical third.

j^1. Head wider. Prothorax wider, with more acute hind angles. Elytra apically produced in a short but very acute, denticulate spine. The spots are formed of golden pilosity; 6 to 7.5 millimeters. (Key Island.) .... **A. xenius sp. nov.**

j^2. Head narrower. Prothorax less wide, with less acute hind angles. Elytra simply rounded at tip. Elytral spots formed of white pilosity; 6 millimeters. (Borneo.) .... **A. sandakanus sp. nov.**

h^2. Last ventral segment emarginate at tip. Prosternal (gular) lobe distinctly emarginate.

i^1. Uniformly cupreous, each elytron with a small spot of pale yellowish pubescence near suture and on apical third. Prehumeral carina of prothorax reaching nearly to apical angles. First joint of hind tarsi fully as long as the four following joints united; 7.5 millimeters. (Mindanao.)
A. bisignatus Fisher.

i^2. Dark violaceous, with cupreous luster, front bright green; on each side of suture a long longitudinal fascia, reaching to middle of elytra, where it is dilated arrowlike (a similar spot on suture in apical fourth); both formed of a silvery, silky white pilosity. Prehumeral carina strong, but shorter. First joint of posterior tarsi as long as the two next joints united; 5 millimeters. (Sulu Island.)
A. atratulus sp. nov.

g^2. The white, gray, or yellow elytral pilosity not disposed in distinct ornamentations.

h^1. The equal pilosity of elytra interrupted near apical third by a transverse, denudate, sometimes darker-colored fascia.

i^1. Prosternal (gular) lobe simply rounded. Last ventral segment truncate at tip. Æneous, head and pronotum violaceous. Elytral pilosity white. First joint of posterior tarsi as long as the three next joints united; 4.5 millimeters. (Borneo.)
A. oppositus sp. nov.

i^2. Prosternal (gular) lobe in front and last ventral segment at tip emarginate.

j^1. Smaller. Æneous, prothorax brassy green, front bright green; emargination of last ventral segment small but well defined, with sharp acute angles; 3.1 millimeters. (Borneo.)
A. microtatus sp. nov.

j^2. Larger; color otherwise.

k^1. Color olivaceous, bronze, head dull green, each elytron with transverse, denudate, dark band at apical third. First joint of posterior tarsi fully as long as the four following joints united; 5 to 6.25 millimeters. (Mindanao and Luzon.)
A. philippinensis Fisher.

k^2. Cupreous, elytra æneous, with darker, denudate, transverse preapical fascia. First joint of posterior tarsi as long as the three following joints united; 5 millimeters. (Kinabalu, Borneo.)
A. operosus sp. nov.

h^2. Without transverse preapical denudate or dark bands on elytra.

i^1. Elytral pilosity disposed in more or less distinct longitudinal vitta, denser along suture.[5]

j^1. Prosternal (gular) lobe distinctly emarginate in middle. Head greenish blue, pronotum and base of elytra blue, with a strong violaceous tinge, balance of elytra purplish brown, becoming violaceous toward apex. Elytral pilosity indistinct, forming an inconspicuous elongate vitta along suture. Front with a deep median impression; 11 millimeters. (Luzon.) ... **A. aguinaldoi** Fisher.

j^2. Prosternal (gular) lobe broadly rounded, not emarginate. Head and prothorax bright green, elytra darker, obscured toward apex, with a subsinuate yellow longitudinal vitta along suture, only distinct from behind the middle toward apex; 6 millimeters. (Singapore.)
A. singaporensis sp. nov.

i^2. Elytral pilosity equal, distinct; in some cases rather indistinct on the declivate sides of elytra or a little condensed along suture.[5]

j^1. Anal segment distinctly emarginate at tip. Prosternal (gular) lobe indistinctly emarginate in front. Short, rather robust, head green, pronotum piceous, with a strong æneous tinge; elytra piceous, with a metallic tinge, covered with semierect whitish pubescence. Tip of intercoxal process wide and biemarginate; 4.7 millimeters. (Mindanao.) .... **A. butuanensis** Fisher.

j^2. Last ventral segment rounded at tip.

k^1. Prosternal (gular) lobe distinctly emarginate at middle.

l^1. First joint of posterior tarsi relatively short, as long as the two following joints united. Elytral pilosity white, very short, indistinct

[5] See *Agrilus tayabensis* Fisher.

toward sides. Marginal carina of prothorax straight, prehumeral carina convex, reaching marginal carina in front of middle. Front with parallel sides, rather wide, prothorax rather short. Æneous; 4.5 millimeters. (Sulu Islands.) .... **A. tardulus** sp. nov.

*l*². First joint of posterior tarsi distinctly longer than the next two joints united.

*m*¹. Prehumeral carina of prothorax convex, reaching marginal carina at middle.

*n*¹. First joint of posterior tarsi as long as the three following joints united. Æneous, rather shining; elytra covered with distinct and rather dense golden pilosity; 5 millimeters. (Borneo.) **A. pilipennis** sp. nov.

*n*². First joint of posterior tarsi as long as the four following joints united. Color olivaceous bronzy, with head dark green (male) or cupreous (female). The yellow pilosity forms a broad inconspicuous vitta along suture; 5.2 millimeters. (Luzon.) .... **A. tayabensis** Fisher.

*m*². Prehumeral carina of prothorax convex, but distinctly longer, reaching marginal carina near anterior third or in anterior angles.

*n*¹. First joint of posterior tarsi as long as the four following joints united. Color olivaceous bronzy, head green (male) or cupreous (female); disk of pronotum slightly purpureous. Elytral pubescence formed of a rather dense, short, semi-erect white pilosity, becoming indistinct along lateral margin. Tip of intercoxal process attenuate. Prehumeral carina of prothorax reaching marginal carina near apical angles; 4.5 millimeters. (Mindanao and Luzon.) .. **A. attenuatus** Fisher.

*n*². First joint of posterior tarsi as long or nearly as long as the three following joints united. Prehumeral carina of prothorax a little shorter, reaching marginal carina in or nearly in apical third.

*o*¹. More robust. Head wider, green, without distinct median impression on vertex. Color cupreo-violaceous. Elytra covered with a very short, fine, very dense, equal white pilosity. Undersurface very densely, shortly, finely pilose; 5.5 millimeters. (Borneo.) **A. uniformipubis** sp. nov.

o^2. Slender, narrower. Head much narrower, with distinct median impression in the middle of vertex. Color dark æneous, the elytral pilosity much less dense, yellow, rather indistinct toward sides; 5 millimeters. (Sulu Islands.)
A. pilistoma sp. nov.

k^2. Prosternal (gular) lobe simply rounded, not emarginate. Prehumeral carina of prothorax reaching lateral margin near apical third.

l^3. First joint of posterior tarsi longer than the four following joints united.

m^1. Intercoxal process parallel between and behind coxæ. Color piceous, head and legs greenish. Elytra sparsely clothed with rather long recumbent pubescence; 3.3 millimeters. (Mindanao.)
A. dapitanensis Fisher.

m^2. Intercoxal process expanded behind coxæ. Color olivaceous bronzy, head and legs green. Elytra covered with distinct short yellowish pubescence; 4.25 millimeters. (Luzon, Mindanao, and Basilan.)
A. manilensis Fisher.

l^4. First joint of posterior tarsi shorter, distinctly shorter than the four following joints united.

m^1. First joint of posterior tarsi relatively longer, nearly the length of the three following joints united. Color cupreous æneous. Head less convex, wider. Front narrower, with a stronger median impression on vertex. Prehumeral carina of prothorax stronger and longer. Elytra longer, distinctly pilose; 4.5 millimeters. (Sulu Island.) .... **A. luctuosellus** sp. nov.

m^2. First joint of posterior tarsi very short, equal in length to the two following joints united. Color dark æneous. Head distinctly more convex, narrower, with distinctly much wider front. Size shorter. Prehumeral carina of prothorax shorter, much more feebly indicated, less convex. Elytra covered with a very short and rather inconspicuous, white pilosity, which is indistinct on sides; 4 millimeters. (Sulu Island.)
A. ludificator sp. nov.

f^2. Elytra behind humeri, with a more or less strong, sharp, straight humeral carina.

g^1. Elytra with denudate (sometimes darker) preapical transverse band.

h^1. Anal segment rounded at tip. Prehumeral carina of prothorax reaching lateral margin in the middle.

i^1. Transverse, dark, denudate band behind the middle; humeral carina of elytra reaching to basal third. First joint of posterior tarsi as long as the four following joints united. Elongate, slender, head and pronotum brassy green; elytra piceous, with a strong metallic luster, covered with short white hairs; 4 millimeters. (Palawan.)
A. inermis Fisher.

i^2. Transverse, dark, denudate band in apical third; humeral carina of elytra reaching to basal two-fifths.

j^1. Larger. Prehumeral carina of prothorax convex, sharp. Front narrower, with more-distinct median impression on vertex. Black, the pilosity of elytra rather indistinct and white, forming a rather indistinct transverse white fascia in front of the denuded preapical fascia; 4 millimeters. (Singapore.) .... **A. carinipennis** sp. nov.

j^2. Smaller. Prehumeral carina much less convex, very near to lateral margin. Front wider, shorter, with rather indistinct impression on vertex. Sides of prothorax greenish, front bluish, elytra nearly black, covered with equal yellow pilosity. First joint of posterior tarsi as long as the two following joints united; 3.2 millimeters. (Singapore.)
A. persolitarius sp. nov.

h^2. Last ventral segment distinctly emarginate or sinuate at tip.

i^1. Elytra with basal two-thirds and apical fourth uniformly clothed with white or yellowish pubescence. Prehumeral carina joining lateral margin (= lateral carina) near anterior angles.

j^1. Humeral carina reaching to middle of length of elytron. Head green, pronotum cupreous, with a purplish tinge, elytra brassy green, with a broad transverse purplish band at apical third; 3.25 millimeters. (Palawan.) .... **A. minutus** Fisher.

j^2. Humeral carina reaching to basal third of the length of elytron. Æneous, head green. First joint of posterior tarsi as long as the three following joints united; 3.2 millimeters. (Basilan.)
A. carinellifer sp. nov.

i^2. Elytra with apical fourth and transverse band just behind middle, clothed with white pubescence. Cyaneous green, head swollen on vertex, beneath bronzy; 2.5 lines. (Mindanao.).
A. pulcher E. Saunders.

g^2. Elytra without denuded, dark preapical band, equally pilose, rarely with a more distinct spot near apex.[6]

[6] *Agrilus malinaoensis* Fisher.

h^1. Last ventral segment sinuate or more or less sharply emarginate at tip.

i^1. Prosternal (gular) lobe distinctly sinuate or emarginate.

j^1. First joint of posterior tarsi as long as the four following joints united. Prehumeral carina of prothorax longer, extending to lateral margin at apical third. Humeral carina of elytra very short. Rather robust, head green, pronotum piceous, with a strong æneous tinge, elytra piceous, with a metallic tinge; 4.7 millimeters. (Mindanao.)
A. butuanensis Fisher.

j^2. First joint of posterior tarsi as long as the three following joints united. Prehumeral carina of prothorax shorter, extending to lateral margin near the middle. Humeral carina longer, reaching behind basal third of the length of elytron. Elongate, slender, brassy green, shining, covered with white, fine pubescence; 4.7 millimeters. (Sulu Island.) .... **A. pterochlorus** sp. nov.

i^2. Prosternal lobe rounded or subtruncate in front.

j^1. Humeral carina of elytra long, reaching to middle of length of elytron. First joint of posterior tarsi as long as the four following joints united. Rather slender, olivaceous bronzy, varying to cupreo-æneous. Prehumeral carina of prothorax joining lateral margin a little in front of middle. Tip of intercoxal process attenuate, with the angles obtuse; 5.25 millimeters. (Mindanao.)
A. davaoensis Fisher.

j^2. Humeral carina shorter. First joint of posterior tarsi as long as the two following joints united.

k^1. Humeral carina very short. Prehumeral carina of prothorax extending to lateral margin near anterior angles. Tip of intercoxal process wide and biemarginate, with the angles very acute.

l^1. Elytra cupreous, with two indistinct white spots along suture near apex. Size robust; 5.25 millimeters. (Luzon.)
A. malinaoensis Fisher.

l^2. Elytra greenish bronze, form slenderer; 4 millimeters. (Luzon and Mindanao.)
A. iliganensis Fisher.

k^2. Humeral carina of elytra reaching to basal fifth. Prehumeral carina of prothorax shorter, strong, reaching only to middle of length of prothorax and not joining lateral margin anteriorly. Dark æneous, short, feebly shining; 4 to 5.7 millimeters. (Mindanao.) **A. cannulus** sp. nov.

*h*². Last ventral segment rounded or subtruncate at tip.

*i*¹. First joint of posterior tarsi as long as the four following joints united. Humeral carina of elytra reaching to basal third. Elytra clothed with short, whitish pubescence.

*j*¹. Prosternal (gular) lobe rounded. Tip of intercoxal process wide and biemarginate, with the angles very acute. Olivaceous bronzy, sides of front nearly parallel. Prehumeral carina of prothorax close to lateral margin and joining it near the apical angles; 4.3 millimeters. (Luzon.)

A. immaculatus Fisher.

*j*². Prosternal lobe distinctly sinuate. Tip of intercoxal process attenuate, with the angles obtuse. Color olivaceous bronzy, varying to cupreo-æneous. Sides of front nearly parallel, slightly arcuately emarginate from vertex to clypeus. Prehumeral carina of prothorax joining lateral margin a little in front of middle; 4 to 4.75 millimeters. (Palawan and Mindanao.)...... **A. mindanaoensis Fisher.**

*i*². First joint of posterior tarsi shorter, never so long as the four following joints united.

*j*¹. Prosternal (gular) lobe distinctly emarginate. First joint of posterior tarsi as long as the three following joints united. Elongate, æneous; elytra covered with fine yellow pubescence; 3.8 to 4.2 millimeters. (Basilan and Mindanao.)

A. exclusus sp. nov.

*j*². Prosternal (gular) lobe rounded; first joint of posterior tarsi as long or nearly as long as the two following joints united, distinctly shorter than the three following joints united.

*k*¹. Humeral carina of elytra very short, reaching only to basal fifth of length of elytron. Elongate, finely sculptured, æneous. Elytra covered with dense, very fine, silky, white pubescence; 4.5 millimeters. (Wellesley, Malay Peninsula.)

A. perniciosellus sp. nov.

*k*². Humeral carina longer.

*l*¹. Humeral carina reaching to basal two-fifths of elytron.

*m*¹. Front rather wide, feebly but distinctly converging apically. Head more convex, wider. Prothorax wider, moderately rounded on sides. Dark æneous; median part of prothorax obscured. Elytra covered with uniform golden pubescence; 3.2 millimeters. (Singapore.)........................ **A. lazar sp. nov.**

*m*². Front a little narrower, with parallel sides. Head less convex, narrower. Prothorax longer, with nearly straight sides. Head greenish, prothorax æneous, in the middle with a coppery tinge; elytra dark æneous, covered with fine white pilosity, which becomes nearly obsolete toward sides; 3.5 millimeters. (Malay Peninsula.)

A. oneratus sp. nov.

*l*². Humeral carina shorter, reaching only to basal third of elytron. Sides of eyes nearly parallel.

*m*¹. Tip of intercoxal process wide and dilated. Head narrower, with eyes not prominent. Frontal rugosity strong, distinct, transverse. Lateral (= marginal) carina of prothorax straight. Dark æneous, head black (male) or greenish blue (female). Elytra covered with fine yellow pilosity; 4.2 to 5 millimeters. (Mindanao.)

A. optatus sp. nov.

*m*². Intercoxal process parallel-sided, with acute tip. Head wider, more convex, with eyes little prominent laterally. Front shagreened in middle only, without distinct rugæ. Lateral carina of prothorax distinctly sinuate anteriorly. Æneous, rather obscure, covered with grayish pubescence; 4.2 millimeters. (Borneo.)

A. perniciosus H. Deyrolle.

Agrilus croceisquamis sp. nov. Plate 2, fig. 20; Plate 4, fig. 9.

Elongatus, attenuatus; corpore subtus aeneo, prosterno obscure aeneo, lateribus abdominis plus minusve auratis, capite nigrescente, thorace cyaneo-viridi, obscuro, lateribus tenue clarissime aureo marginatis. Elytris in parte dorsali (sub pubescentia fulva) viridi-aeneis, lateribus plus minusve cyanescentibus, obscuris, dimidio apicali cyaneo. Capite in parte praeorali usque ad mediam longitudinem pube dense aurea tecto, parte ulteriori (frontali) glabrata, rugis transversis ac in fronte verticalibus ornata. Fronte largitudine bis longiori lateribus subparallelis, in parte quarta posteriori leviter subsinuatis, hoc loco marginibus frontalibus subimpressis. Oculis normalibus. Thorace longitudinis $1\frac{1}{4}$ latiore, marginibus rectis, ad angulos basales leviter convergentibus, antice macula e pilis densis aureis composita ornatis. Scutello lato, carinato. Elytris latitudine $3\frac{1}{2}$ longioribus, lateribus attenuatis et pone medium subsinuatis (parte laterali abdominis segmenti primi,

pilis densis, fulvis ornati desuper visibili) apice unidentatis, subspinosis; duobus spinis angulum suturalem elytrorum efficientibus; margine apicali laterali usque ad dentem apicalem subsinuato. Abdomine dense ac regulariter subtilissime punctato, apice integro. Tergite ultimo supra in medio (sub elytris) longitudinaliter carinato hac carina in processum curtum ac linearem prolongata, qui in angulo amborum elytrorum, quem deus uterque apicalis medius efficit, desuper visibilis est.

Patria: Borneo, Kinabalu (coll. *Obenberger*). Long. 7.5 mm.

This species is very distinct from the other species of the Oriental Region known to me.

Head golden in anterior part, covered with a fine, dense golden pilosity, the other (frontal) half of head black and without distinct pilosity; rugosity of this part transverse, the frontal rugæ perpendicular. Eyes not prominent laterally. Prothorax long, only 1.25 times broader than long, covered with dense, fine rugæ; with a very slight depression before middle and a similar transverse depression before base. Laterally with a distinct depression, which is well marked in the anterior angles, where there is a small but very distinct golden spot of fine, very dense pilosity. Middle part of prothorax dark bluish green, margins pale golden. Prehumeral carina short but very distinct, marginal (lateral) carina subsinuate, and from above distinctly visible; submarginal carina in the anterior angles rather distant from lateral carina; these carinæ converge in the middle and unite in the basal angles. Scutellum transversely carinate and large. Elytra long and attenuate, with a strong median tooth at tip, very finely and roughly sculptured. In anterior half of elytra, along suture, is a large vitta, covered with regular, dense, short, fine golden pubescence; the ground color of this vitta is æneous. A similar but very small spot near suture at apex. Remainder of elytra darker, laterally cyaneous or (apically) distinctly bluish without distinct or (apically) with very short dark pubescence. Legs and antennæ (triangular from fifth joint), greenish. Undersurface more shining and clearer than upper surface. Last abdominal tergite marked with a strong median carina, which is apically prolonged in a linear and short but very distinct process.

An example of this very interesting species, which resembles some species from southern America, was taken at Kinabalu (central Borneo) and is deposited in my collection (ex coll. Meyer-Darcis).

Agrilus pictithorax sp. nov. Plate 2, fig. 33; Plate 4, fig. 23.

Elongatus, tenuis, aeneo-virens; vertice thoracisque disco late indigaceis. Elytris longis, unispinosis, pube brevi albida pone medium transverse denudata; partibus elytrorum denudatis obscuratis. Capite subconvexo, vertice sulcato; antennis aeneis, ab articulo quarto vel quinto violaceis, ab articulo quarto (incl.) dentatis. Prothorace longitudine $1\frac{1}{4}$ latiore, antice valde bisinuato, lateribus ad basim attenuatis, carina praehumerali forti, curvata, carina laterali bisinuata, carina submarginali minus recurva, in angulo basali cum illa conjuncta. Scutellum transverse carinatum. Lobo gulari rotundato, in medio paullulo, indistincte subemarginato. Elytris longis, apice unispinosis, haec spinae denticulis aliquot lateralibus. Abdomine convexo, minute dense punctato, segmento primo medio subgranuloso; superficie abdominali regulariter albo pubescente; hac pube in sterni partibus lateralibus densiore. Abdominis segmento ultimo emarginato. Pedibus longis, articulo tarsorum posteriorum primo longitudine quatuor sequentes attingente. Unguiculis dentatis, dentis non convergentibus.

♂ ♂ : Prosterno medio pube densa erecta aurea, abdominis segmento primo granulis duabus approximatis.

Patria: Borneo, Sandakan (*Baker*). Long. 5.4–6.5 mm.

Elongate, cylindric, disk of elytra a little depressed. Head large, rather convex; eyes not prominent laterally. Front green (male) or cupreous (female), long, feebly sinuate on sides, with impressed external margins in the form of narrow channels. Anterior part (perhaps one-third the length) densely and finely transversely strigate, covered with a fine yellow pubescence. Upper part finely shagreened, not striate, with some fine punctures. Vertex distinctly, deeply impressed and finely, longitudinally striate. Antennæ æneous, from fourth or fifth joint violaceous, serrate from fourth joint, long and narrow. Prothorax subcordiform, 1.5 times broader than long, in anterior half parallel, then narrowed to base; anterior margin strongly bisinuate. Prehumeral carina convex, reaching to middle of prothorax, approaching there the lateral carina, sharp and convex; lateral carina strongly bisinuate in anterior part; submarginal carina a little curved, less sinuate than marginal and joining it in the hind angles. With a large transverse depression before base and with a smaller depression in the anterior angles. Vertex and greater part of prothorax dark blue or indigo; only the margins of thorax

golden green. Sculpture consisting of fine curvate concentric striæ. Gular lobe with extremely small emargination. Scutellum transversely carinate. Elytra long; lateral part of first abdominal tergite exposed; greenish olive to three-fifths of length, then obscurate; apices æneous, unispinose; green parts covered with fine white pilosity; the obscure band covered with dark short hairs and apparently glabrous. Abdomen convex, last ventral segment emarginate at tip. Claws simply cleft, the lower portion not inverted. Last abdominal tergite with projecting carina.

Male.—Head green, middle of prosternum covered with close yellowish hairs. Middle of first ventral segment with two approximate granules.

Agrilus tristinus sp. nov. Plate 3, figs. 3, 44.

Obscure cyaneo-viridis, elongatus, convexiusculus. Capite lato, angulos prothoracis anticos latitudine non superante. Fronte longitudinaliter impressa, transverse rugosa ac sparse albido pilosa, lateribus convexis ac paulo rotundatis; vertice impresso; antennis viridibus, curtis, ab articulo quarto (incl.) dentatis. Prothorace longitudine $1\frac{1}{2}$ latiore, lateribus prope angulos anteriores latissimis, dein ad basim attenuatis; disco thoracis impressione lata transversa praebasali et utrinque depressione minore laterali, rugis transversis antice granuliformibus ac interruptis. Carina praehumerali curta ac valde convexa, carina laterali fere recta, antice paulo declivi, carina submarginali usque ad tertiam partem basalem cum illa subparallela, dein valde convergente ac in angulis basalibus cum ea conjuncta. Lobo gulari emarginato. Scutello latissimo, transverso, carinato. Elytris dense granuloso-rugosis, pone medium subdilatatis, dein ad apicem attenuatis. His curte unispinosis. Pube indistincta obscura; solum pone medium vitta parva suturali ac ante apicem vitta simili minore alba. Pygidium carina curta projecta ornatum. Abdomen convexum, nitidum, dense subtiliter punctatum ac albido pubescens. Tarsis curtis; tarsorum posticorum articulo primo tres sequentes longitudine attingente. Segmento anali emarginato. Unguiculis simpliciter dentatis, dentibus internis non convergentibus.

Patria: Singapore (*Baker*). Long. 5 mm.

I have before me the single specimen of this species found by Baker. In size and color this species somewhat resembles *A. angustulus* Illiger of Europe.

Elongate, cylindric, convex. Head rather convex, front longitudinally impressed, laterally feebly rounded; lateral margins impressed in the form of a small narrow channel. Gular lobe emarginate. Prothorax short and broad, laterally feebly narrowed to base, before base subsinuate, with acute hind angles. Thoracic sculpture dense and fine; the rugæ sometimes interrupted and behind anterior margin granuliform. Scutellum very large and carinate. Elytra not very long, a little enlarged behind middle, then attenuate to apex which is shortly unidentate. Apical spine short and situated nearer suture, the two spines forming a small angle on suture, in the middle of which is visible the small and short projecting carina of pygidium. Pilosity of elytra dark on suture behind middle, and shortly before apices two small, white, pubescent spots; other pilosity feebly visible. Abdomen convex, very finely, densely punctate, and covered with a fine, short, white pilosity. Last ventral segment emarginate.

This species is very distinct in consequence of the form of the elytra, short antennæ and tarsi, general form, etc.

Agrilus spinellifer sp. nov. Plate 2, fig. 5; Plate 3, fig. 21.

Convexus, cylindricus, corpore subtus aureo, fronte cuprea, vertice, thorace elytrisque obscure viridibus, elytris ad latera et ad apicem obscuratis. Capite lato, fronte lata, lateribus subparallelis, superficie frontis fere glabra, dense transverse, satis minute strigoso rugoso. Vertice subtiliter longitudinaliter impresso, dense transverse strigoso rugoso. Antennis cupreis, ab articulo quarto dentatis; articulis dentatis albo pilosis. Thorace convexo, transverso, ante basim haud, in angulis anticis leviter impresso, margine antico sinuato; longitudine fere $1\frac{1}{2}$ latiore, lateribus leviter rotundatis, latitudine maxima in medio; superficie dense transverse strigoso rugoso. Carina praehumerali deficiente, carina laterali (= margine) fere recta, carina submarginali leviter sinuata, antice divergenti. Lobo gulari distincte emarginato. Scutello lato transversim carinato. Elytris convexis, cylindricis, abdomen totaliter tegentibus, pone medium leviter dilatatis, dein ad apicem leviter rotundato-attenuatis ac hic separatim unispinosis. Hac spina apicali forti, tenui, acutissima, mediana. Elytris ambo conclusis angulus parvus suturalis aperit. Sculptura elytrorum minutissima sed granulosissima, densissima, substrigosa aequali; elytris fere glabratis, pube obscura fere invisibili tectis. Abdomine nitido, convexo, minutissime sparse punctato

ac albido pubescente. Pedibus aeneis; tarsorum posticorum articulo primo tres sequentes longitudine adaequante. Unguiculis simpliciter dentatis. Abdominis segmento ultimo apice rotundato, integro.

Patria: Borneo, Kinabalu (coll. *Obenberger*). Long. 7 mm.

Elongate, cylindric, upper surface feebly shining, undersurface more shining. Undersurface golden; upper surface dark green, nearly without luster; front cupreous. Head rather convex, broad, front broad, laterally nearly parallel, with a very distinct but relatively fine, rough sculpture, consisting of transverse rugæ. Vertex feebly impressed, green, transversely densely sculptured. Prothorax convex, without depression before scutellum, the greatest width near the middle, laterally moderately rounded, with fine oblique impression within the anterior angles. Without prehumeral carinæ in the hind angles. Thoracic sculpture relatively fine, but rough, strigose and rugose. Gular lobe emarginate. Scutellum large and transversely carinate. Elytra long, cylindric, a little dilated behind the middle and then finely, roundly narrowed to apex, where they are separately and very acutely unispinose. Apical spine long, narrowed, and very acute, situated in middle of apex. Elytral sculpture extremely dense, granulose, and very fine but rough; elytra nearly glabrous, pubescence very dark and inconspicuous; laterally elytra cover entire abdomen. Elytra dark green, but sides and ends obscurate. Abdomen convex, shining, with very fine and sparse equal puncturation, without impression. Surface of abdomen covered with a very short but distinct, sparse puncturation. Legs golden, tarsi relatively short, first joint of hind tarsi as long as the following three together. Claws simply cleft, lower portion not turned inward.

This species is very easy to distinguish from the other species of the Oriental fauna. It comes in the group of Agrili characterized by the absence of prehumeral carina in the hind angles of prothorax. In this group it is very remarkable by its sculpture, form of front, elytra, and the end of the last ventral segment which is rounded and entire. I have in my collection only a single specimen of this remarkable species.

Agrilus purpurifrons H. Deyrolle. Plate 2, fig. 40; Plate 3, fig. 41.

An obscure, dark species, with purplish front. Rather rare in collections. One specimen of this species was taken in Singapore (*Baker 12609*).

Agrilus acutus Thunberg. Plate 3, figs. 15, 37.

This species is mentioned by Fisher as occurring in the Philippine Islands, but it was not seen by him.

I have added here a figure of this widely distributed species, of which I have in my collection many specimens from Java, Sumatra, Borneo, and the Philippines; also from eastern India, where it finds its western limit (Madras, Shembaganoor, etc.).

This species is bright blue, with very acute tips to the elytra, with a more or less developed transverse white fascia in the middle, and with a smaller preapical similar fascia on each elytron.

Agrilus acutus ab. **asphaltipennis** ab. nov.

This aberration diverges from the typical form by the black upper surface. The haired fasciæ are often absent. Undersurface blue, similar to the typical form. There are many specimens in my collection. This aberration probably occurs also in the Philippine Islands.

Patria: Sumatra, Medan (*Corporaal* leg.); western Java, Pengalingan, 1893 (*H. Frühstorfer* leg.).

Agrilus piperi Fisher. Plate 3, figs. 14, 36.

This species seems to be very similar to *A. luzonicus* Kerr. I have in my collection a specimen, which I had considered as *luzonicus*. In the original description of *piperi*, however, the two species are not clearly distinguished.

Agrilus ornatus Deyrolle.

This is a characteristic species of New Guinea. I have never seen a specimen from the Philippines, but there are some very similar forms in Oriental regions, and it is not impossible that the Philippine "*ornatus*" may constitute a separate species.

Agrilus dajakorum sp. nov. Plate 2, fig. 39; Plate 3, fig. 40.

Viridis, smaragdineus, nitidus, elytris apicem versus obscuratis, prope apicem vitta curta subsuturali albida. Infra smaragdineus, nitidissimus, abdominis nullo viridi aurato. Capite lato, latitudine partem thoracis anteriorem paullo superante, viridissimo, micante. Fronte plana, glabra, confertim transverse rugosa; lateribus sinuatis. Vertice linea impressa. Antennis longis, ab articulo quarto (incl.) dentatis, viridibus. Prothorace smaragdineo, nitido, longitudine 1¼ latiore ad latera profunde impresso, aequaliter subtiliterque transverse rugoso.

Carina praehumerali curta fortique; carina laterali fere recta, carina submarginali subsinuata, ad apicem modeste divergente, in angulo basali cum illa laterali conjuncta. Lobo gulari manifesto, rotundato, integro. Scutello pentagonali, carinato. Elytris longis, attenuatis, planis, pone medium subdilatatis, dein apicem versus modeste attenuatis; apicibus trispinosis; spina media manifeste producta acutissimaque. Elytris subtilissime transverse granulosis, sculptura in parte apicali minutissima; sine impressionibus; colore elytrorum antice viridi-obscuro, dein obscuriore usque subnigro; aspecto elytrorum glabro, solum ad apicem vitta curta albida ornatis. Abdomine convexo, minutissime punctato; abdominis segmento primo granulis duobus approximatis (♂); segmento anali emarginato. Tarsis posticis longis, articulo tarsorum posteriorum primo tres articulos sequentes longitudine superante.

Patria: Borneo, Sandakan (*Baker*). Long. 9 mm.

Form elongate, parallel; head and prothorax splendid green; elytra in anterior part obscure green, then darker, apices nearly blackish. Head a little broader than prothorax; front glabrous, with splendid luster, with dense transverse striation; front sinuate laterally. A small linear impression on vertex. Prothorax $1\frac{1}{7}$ times broader than long, with sides nearly straight. Prehumeral carina very well developed, short and convex. Lateral carina strong and nearly straight. Gular lobe large and broadly rounded. Antennæ long, green, dentate from fourth article. Scutellum pentagonal, carinate. Elytra long, equal, feebly shining, with a very fine sculpture, elongate, and very feebly attenuate to end where they are strongly trispinose. Median spine very strong and well developed. Color of apical part very dark, the sculpture there very fine, with a fine subsutural vitta before apex, consisting of fine white pubescence. Abdomen convex and more shining than upper surface, bright golden green. First abdominal segment with two small granulations on middle (male). Last ventral segment distinctly emarginate. The inner two-thirds of posterior femora with short, erect, dense, white pubescence (male). Tarsi long; first joint of posterior tarsi longer than the three following joints. Claws simply cleft, lower portion not inverted.

I have before me also one specimen of this species from Singapore (*Baker*).

Agrilus insularis H. Deyrolle. Plate 2, fig. 13; Plate 3, fig. 30.

Two specimens of this species were taken at Sandakan, Borneo (*Baker*).

Agrilus albogaster H. Deyrolle. Plate 2, fig. 15; Plate 3, fig. 31.

Four specimens were taken at Sandakan, Borneo (*Baker*). To the original description of *Agrilus albogaster* I can supply the following characters:

1. Last abdominal tergite with projecting carina at tip.
2. The males of this species have two small granules on the middle of first abdominal segment and a white pilosity in the middle of prosternum.
3. Gular lobe rounded, without trace of emargination.

This species was described from Borneo and Singapore.

Agrilus saundersianus sp. nov. Plate 2, fig. 30; Plate 4, fig. 20.

I have had in my collection a species of *Agrilus* which I had considered to be *nigrocinctus* E. Saunders. Now, with the specimens from the Baker collection, come two specimens of a very similar species which I now recognize as the proper *nigrocinctus* of Saunders, and the species of my own collection is a very similar, new species. *Agrilus nigrocinctus* is relatively common in Mindanao. I consider it sufficient to indicate only the distinctive characters of my new species, as follows:

1. Length, 6 millimeters. General form and size as in *A. nigrocinctus;* a strongly developed, medially produced carina on pygidium; the system of pubescence distribution is similar to that of *nigrocinctus.*
2. Head less convex, front more depressed, a little narrower, and greenish. Vertex not obscurate.
3. Prothorax a little shorter, green, unicolorous, without golden margins. Lateral carina straight (in *nigrocinctus* a little sinuate), prehumeral carina more convex, submarginal carina more convergent to base and joined to lateral carina before base (not in basal angle as in *nigrocinctus*).
4. Gular lobe very distinctly emarginate, separated from remainder of prosternum by a deep transverse impression. In *nigrocinctus* this emargination is very feeble and the gular lobe is separated rather indistinctly from prosternum.
5. Scutellum longer.
6. Elytra similar to those of *nigrocinctus;* two apical spines shorter and more distant.
7. Abdomen and upper surface paler, more shining; abdomen golden green, upper surface bright green. Obscure elytral vitta not so apparent and not so dark. The male has two approximate granulæ on first abdominal segment. The other characters, namely, those of antennæ and legs, are the same as in *nigrocinctus.*

Patria: Philippines (coll. *Obenberger*). Long. 6 mm.

Agrilus nigrocinctus E. Saunders. Plate 2, fig. 12; Plate 3, fig. 28.

Described from the Philippines. I have added to this work a figure made from the specimens in my collection.

Agrilus inquinatus E. Saunders. Plate 2, fig. 16; Plate 3, fig. 32.

Some specimens of this species come from Basilan Island and from Dapitan, Mindanao (*Baker*). The species is very similar to *Agrilus simillipictus* sp. nov. from Borneo, but differs in the following important details:

1. Head more convex. Front narrower and longer.
2. Thorax different; median lobe of anterior margin more strongly advanced toward vertex. Lateral and submarginal thoracic carina anteriorly more divergent and more distant. Prehumeral carina more convex, longer. Prothorax with better-indicated longitudinal impression in middle.
3. Pygidial carina shorter and less developed.

Agrilus simillipictus sp. nov. Plate 2, fig. 34; Plate 4, fig. 24.

Agrilo albogastri H. Deyrolle simillis ac valde affinis. Colore aureo-viridi, prothorace concolore. Elytris pone medium macula obscura regulari ac rotunda, obscure pubescente ornatis. Elytrorum superficie pube candida regulariter tecta. Capite minus convexo quam apud *albogastrum*, fronte minus convexa, minus fortiter impressa; thorace concolore, in angulis anticis latitudinem maximam attingente (apud *albogastrum* in tertia parte anteriori), carina praehumerali distincta, longa, convexa, in medio thoracis longitudinis cum carina laterali conjuncta; carina submarginali cum illa valde divergente, in angulis basalibus juncta. Elytris viridibus, etiam in apice concoloribus, pube multo subtiliore quam ut *albogastrum* tectis, apicibus bidentatis. Macula obscura valde divergente: haec apud *albogastrum* fasciam transversam efficit, hic macula illa rotunda latera non attingit atque etiam anterior quam apud *albogastrum* posita est. Segmento anali emarginato; lobo gulari paulo sed distinctissime emarginato (apud *albogastrum* solum indistincte truncato). Tergitum ultimum quam apud *albogastrum* carina media producta ornatum. Tarsorum posteriorum articulo primo tres sequentes longitudine superante (apud *albogastrum* tres sequentes vix longitudine attingente).

Patria: Borneo, Sandakan (*Baker*). Long. 5.5–6 mm.

This species is very similar to *Agrilus albogaster* H. Deyrolle, but differs in the following characters:

Head not so convex, and anteriorly (seen from above) less prominent. Color of upper surface paler, bright olive green, uniform. Sculpture of prothorax similar, but lateral margins straight and attenuate from anterior angles to base. Gular lobe feebly but very distinctly emarginate. The coloration of the elytra is very different. They are unicolorous, only behind

middle with a circular, regular, obscure macula which is also obscurely haired. Remaining surface clothed with white, close pilosity, closer before apex. In *albogaster* the elytral macula is placed more apically and is fasciform, in a large transverse band; granulation stronger and not so close; the pilosity of elytra is golden or yellow and not so close as in the new species. First joint of hind tarsi longer than the three following joints. Last ventral segment emarginate; last abdominal tergite (as in *albogaster*) with distinct projecting carina. Claws broadly dentate, the lower portion not inverted.

Agrilus aureocoerulans sp. nov. Plate 2, fig. 26; Plate 4, fig. 17.

Parvus, nitidus, subelongatus. Capite thoraceque aureis, thorace macula quando cuprea ornato; elytris coeruleis, pube uniformi curta aurea. Capite lato, convexo, oculis convexis, non prominulis. Fronte elongata, vertice levissime impresso. Fronte alutacea, nitida, subglabra, subtiliter transverse rugosa, lateribus leviter subsinuatis ac tenuiter distincte canaliculatis. Antennis aeneis, ab articulo quarto (incl.) dentatis. Thorace longitudine $1\frac{2}{5}$ latiore, lateribus subrotundato, in medio latissimo, glabro, ante basim transverse impresso, in angulis anterioribus impressione levi; disco saepe cuprato; transversaliter subtiliterque ruguloso. Carina praehumerali curta, forti, curvata, carina laterali leviter curvata, carina submarginali antice cum ea valde divergente, postice ei approximata atque in angulis basalibus cum ea conjuncta. Elytris subplanis, tenuissime granulosis, pone mediam subdilatatis, ad apicem attenuatis ac hic separatim ac denticulatis. Lobo gulari integro, rotundato. Abdomine convexo, aeneo, segmento abdominis ultimo integro, apice rotundato. Pedibus aeneis, tarsis curtis, tarsorum posteriorum articulo primo tres sequentes longitudine superante.

♂. Abdominis segmento primo in medio granulis duo approximatis ornato. Segmento anali subtruncato.

Patria: Borneo, Sandakan (*Baker*). Long. 4–5.3 mm.

Small, elongate species. Head and prothorax golden; prothorax in the middle often with a cupreous luster. Head broad and convex, but not broader than anterior margin of prothorax. Eyes convex. Front elongate, narrow, a little subsinuate at sides, inner margin of eyes distinctly and narrowly channeled. Front shagreened, with fine transverse rugosity. Antennæ brassy green, denticulate from fourth joint. Prothorax 1.4 times broader than long, anterior margin sinuate, on sides

gently rounded, having the greatest width near the middle; before base with a large transverse depression; also depressed within the anterior angles. Prothoracic rugosity fine and transverse. Scutellum large and transversely carinate. Elytra long and a little depressed on disk, with very fine sculpture, consisting of subtle granulation. Entire surface covered with a fine, short, regular, golden pilosity. Elytra a little broadened behind middle and regularly narrowed to apex which is separately, very shortly biemarginate or bidentate; this emargination is very feeble. Last ventral segment rounded (female), or truncate (male); first abdominal segment armed with two small granules in middle (male). Undersurface shining, very finely punctate, and pubescent; tarsi short; first joint of posterior tarsi longer than the three following together. Claws simply cleft, inner portion not inverted. Very distinct from all known species from Borneo.

Agrilus falsulus sp. nov. Plate 3, figs. 2, 43.

Infra aeneo-viridis, nitidis, supra obscure cyaneus, solum elytrorum basi tenuiter aenescente. Subcylindricus, elongatus. Capite lato, fronte alutaceo, lateribus paulo subsinuatis; antice subtiliter transverse rugosa et albido pilosa. Thorace longitudine $1\frac{1}{4}$ latiore, in parte tertia anteriori latissimo, ad basim sinuate attenuato, antice bisinuato, lobo medio producto, carina praehumerali curta convexa, carina marginali bisinuata, carina submarginali fere recta, cum illa ad basim forte convergente atque in angulis posticis conjuncta. Disco depressione transversa ante basim atque utrinque impressione laterali; dense subtiliterque transverse rugoso. Lobo gulari emarginato. Elytris disco subdepressis, pone medium dilatatis, minute rugosis atque uniforme obscure pubescentibus; solum prope suturam in parte basali atque distinctius prope apices albido pilosis. Apicibus bidentatis; dente interiore fortiore ac longiore. Subtus nitidus, convexus minute sparseque punctatus ac albido pilosus; segmento anali late emarginato. Tarsis posterioribus satis longis, tarsorum posteriorum articulo primo longitudine tres sequentes adaequante. Unguiculis simpliciter fissis.

♂. Segmento primo abdominali in medio granulis duabus approximatis ornato. Prosterno medio erecte dense albido piloso.

Patria: Singapore (*Baker*). Long. 5.5 mm.

Form of *Agrilus albogaster* Deyrolle. Upper surface dark blue, without strong luster; only base of elytra narrowly æneous.

Head rather broad, front laterally feebly sinuate, shagreened and sparsely punctured; only preoral third part finely transversely rugose and clothed with white pilosity. Margins of front channeled. Vertex feebly but distinctly impressed and longitudinally striate. Prothorax finely transversely striate, having the greatest width in anterior third part, 1.25 times broader than long. Scutellum carinate. Gular lobe very distinctly emarginate. Elytra of the form of *A. albogaster* Deyrolle, but less narrowed and sharply bispinose at tip; interior spine stronger, better developed, and very acute. Elytra leaving uncovered a very small part of lateral margins of abdomen. Entirely clothed with an obscure pubescence; only in basal part near suture and on sutural part of apices the pubescence more distinct and silky white. Last ventral segment emarginate. Undersurface more shining, æneous, very finely and sparsely punctured, and clothed with a very fine, short, white pubescence. Antennæ greenish, dentate from fourth joint. Claws simply cleft, lower portion not inverted.

Male.—In the middle of first abdominal segment with two approximate granules. Middle of prosternum with close erect white pilosity.

Agrilus bidentellus sp. nov. Plate 3, fig. 8; Plate 4, fig. 7.

Aeneus, nitidus, elongatus, subconvexus. Capite convexo, oculis magnis, margine thoracis anteriore paulo latioribus. Fronte modice convexa, alutacea subtiliter sparse punctata, tenui lateribus paulo sinuatis; in parte praeorali pube brevi albido ornata. Vertice longitudinaliter dense striato, paulo impresso. Thorace longitudine $2\frac{1}{2}$ latiore, margine anteriore bisinuato, lobo medio manifeste producto, latitudinem maximam in tertia parte anteriore attingente, dein ad basim et ad angulos anteriores modice attenuato; impressione lata transversa praebasali minore que obliqua in angulis anticis. Carina praehumerali carinae marginali approximata et cum ea in medio thoracis longitudinis conjuncta, convexa; carina marginali recta, carina submarginali cum illa in angulis posticis conjuncta, antice modeste divergente. Thorace in disco fortiter subrotundate transverse striato. Thorace capiteque glabris. Scutello transverse carinato. Elytris subconvexis, pone medium subdilatatis, dein ad apicem modice attenuatis; apicibus separate truncatis, subemarginatis; angulis exterioribus hujus emarginationis subspinosis. Tota elytrorum superficie pube regulari aequalique brevi et albida,

ad suturam paulo densiore ornata, transverse, non dense, subtiliter rugosa. Gulari lobo integro, rotundato; abdominis segmento ultimo rotundato. Subtus convexus, nitidus, minutissime ac sparsissime punctatus atque albide pubescens; pedibus antennisque æneis. His ab articulo quarto (incl.) dentatis. Tarsis? Unguiculis?

Patria: Borneo, Sandakan (*Baker*). Long. 3.9 mm.

This species resembles very much *Agrilus roscidus* Ksw., of Europe.

Brassy green, form rather robust and convex. Head convex; eyes broad and laterally a little prominent. Front laterally a little sinuate, with small, fine lateral channel; anterior margin covered with very fine white pubescence. Front shagreened, sparsely punctured. Vertex feebly and broadly impressed, densely and longitudinally striate. Antennæ æneous, dentate from fourth joint. Prothorax 1.5 times wider than long, anterior margin bisinuate; median lobe extended toward head. Prothorax moderately convex, having the greatest width in anterior third part, with a large transverse depression before base and a smaller impression within the anterior angles; sides moderately attenuate to base and rounded to the anterior angles. Gular lobe porrect, entire, and rounded. Scutellum transversely carinate. Elytra convex, having the greatest width behind middle, where they leave uncovered a small lateral part of the first tergite; surface with a fine and rather sparse transverse rugosity and clothed with very fine, regular, short, white pubescence. Pubescence a little closer to suture. Apices of elytra truncate and feebly emarginate; exterior angle of this emargination feebly spinose. Abdomen and legs shining, paler than upper surface, very finely and sparsely punctate, with traces of very short, sparse, fine, white pubescence. Last ventral segment rounded, entire.

Agrilus intrusus sp. nov. Plate 2, fig. 9; Plate 3, fig. 25.

Elongatus, tenuis, cylindricus, bronceus, nitidus, subtiliter sculptus. Capite convexo, fronte alutacea viridi-aenea, sparse ac subtiliter singulatim punctata, ad partem ovalem leviter convergenti; anti dense albido pilosa; vertice impresso, isolate punctato. Antennis viridi-aeneis. Thorace longo, latitudine ac longitudine fere aequalibus, lateribus rectis, subparallelis, solum ad basim paulo convergentibus. Sculptura minuta rugarum transversalium. Carina praehumerali longa, sinuata, parum

convexa, in prima longitudinis parte tertia cum carina laterali juncta. Illa recta, solum antice paululo declivi. Carina submarginali antice divergente, ad basim iam ante angulum posteriorem cum carina laterali juncta. Thorace convexo, solum ante scutellum impressione levi circulari, unaque simili obliqua in utroque angulo antico. Gulari lobo medio emarginato. Scutello transversim carinato. Elytris longis, tenuibus, pone medium leviter dilatatis, dein ad apicem longe attenuatis ac apicibus bidentatis; spatio inter hoc dentes curtos circulariter emarginato. Carina humeralis elytrorum absente; superficie tota pube brevi aequali pilorum alboscriceorum ornata. Abdomine aeneo, nitido, sparse albo pubescente; hac pilositate lateribus sterni densiori. Segmento anali apice emarginato. Tarsis longioribus, articulo tarsorum posteriorum primo tres sequentes longitudine adaequante. Unguiculis simpliciter dentatis.

Patria: Philippinas (coll. *Obenberger*). Long. 3.5 mm.

This species is very easily to be distinguished from the others by the small, narrowed, attenuate, elongate form and the equal pubescence of elytra, which are bidentate at tip.

Long, narrow, cylindrical, æneous, with rather strong luster; undersurface paler and more shining. Head rather convex and broad, laterally nearly parallel, only at base feebly narrowed, convex, with a feeble oblique impression on each side in the anterior angles and with a feeble rounded impression before scutellum. Gular lobe distinctly but rather feebly emarginate. Scutellum transversely carinate. Elytra very long and rather narrowed, a little dilated behind middle, then moderately narrowed to apex, where they are separately bidentate; these two teeth are short and form the sides of a small circular emargination between them. Sculpture of elytra transverse and with fine, squamiform rugosity; the entire surface covered with equal, short, silky, white pilosity. Underside more shining, rarely and very shortly haired; the white hairs more densely agglomerated on sides of prosternum, mesosternum, and metasternum. Legs rather long, æneous, first joint of posterior tarsi as long as the three following together. Claws simply cleft, lower portion not turned inward. Last ventral segment emarginate at tip.

The single type in my collection resembles very much some specimens of the European *Agrilus roscidus* Ksw. and comes from the collection of Meyer-Darcis, which I determined for Staudinger and Bang-Haas.

Agrilus kheili sp. nov. Plate 3, figs. 13, 35.

Corpore satis robusto, subcylindrico. Capite thoraceque nigris, elytris duobus partibus anterioribus aeneis, lateribus violascentibus, tertia parte apicali nigra, corpore subtus, fronte, pedibusque aeneis, antennis violascentibus, thorace aeneomarginato. Capite satis magno, lateribus haud prominulis, vertice impresso, antennis ab articulo quarto dentatis. Gulari lobo emarginato. Thorace similiter quam apud *discicollis* instructo, carina praehumerali curta, forti. Elytris in parte aenea albopilosis, in parte apicali nigra fascia solum curta subsuturali albida. Segmento anali apice emarginato. Tarsis brevibus, unguiculis profunde fissis, partibus interioribus inversis.

Patria: Mindanao (coll. *Obenberger*). Long. 6 mm.

Very similar to *Agrilus discicollis* H. Deyrolle, of similar color and form, but more robust, larger, and more cylindrical, with distinctly wider front; sides of front distinctly more parallel. Gular lobe distinctly sinuate anteriorly. First joint of posterior tarsi distinctly shorter, as long as the two following joints united. Hind tarsi very short, only about half as long as tibiæ. Claws cleft in such a manner that the lower portion is turned inward, nearly touching that of opposite side. Abdomen rather convex, last ventral segment emarginate at tip.

In my collection is a single specimen of this species, received from Staudinger and Bang-Haas.

I dedicate this species to the Nestor of the entomologists of Czechoslowakia and a competent judge of Oriental and Neotropical Lepidoptera, Prof. Napoleon M. Kheil of Prague.

Agrilus discicollis H. Deyrolle.

A widely distributed Oriental insular species. Rather common in Sumatra.

Agrilus albocinctus Fisher. Plate 2, fig. 3; Plate 3, fig. 19.

The four specimens before me came from Dapitan, Mindanao (*Baker*). A very distinct, rather robust species.

Agrilus agrestis H. Deyrolle. Plate 2, fig. 11; Plate 3, fig. 27.

In the Baker material sent to me for determination was this species from Sandakan, Borneo. It is very remarkable for the broad, convex, and short body. Gular lobe feebly, broadly emarginate; ventral segment on tip with short and angulate but very deep emargination. Claws simply cleft, lower portion not inverted, but they are nearly as long as the broader, external part of the claw.

Agrilus gratiosus H. Deyrolle.

This species is rather common in Borneo and Sumatra. Some specimens were taken in Sandakan, Borneo (*Baker*).

Agrilus subpubescens Fisher. Plate 2, fig. 25; Plate 4, fig. 16.

The two specimens sent were from Dapitan, Mindanao (*Baker*). In this connection an error was committed in Fisher's key to the species.[7] Both *A. subpubescens* Fisher and *A. zamboangensis* Fisher were placed under "16" in the key, species with carinate hind angles of pronotum. In reality, both species have these angles not carinate and should be placed with *bakeri* Kerremans, *rotundipennis* Fisher, and *inconstans* Fisher. The description is correct in the original diagnosis of both species.

Agrilus zamboangensis Fisher. Plate 2, fig. 24; Plate 4, fig. 15.

There were five specimens of this species in this collection, four of them from Dapitan, Mindanao; a single specimen from Kolambugan, Mindanao (*Baker*), belongs in the vicinity of *bakeri* Kerremans, *rotundipennis* Fisher, and *inconstans* Fisher. The position under "16" in the key of Fisher [7] is erroneous.

Agrilus inconstans Fisher. Plate 2, fig. 14; Plate 3, fig. 29.

The examples sent to me are from Dapitan, Mindanao (*Baker*).

Agrilus viridicolor sp. nov. Plate 2, fig. 22; Plate 4, fig. 13.

Viridis, smaragdineus, sutura marginibusque lateralibus elytrorum obscuratis. Capite lato, convexiusculo, linea media lineari; fronte longiore, lateribus subsinuatis, transversaliter subtiliterque rugoso. Thorace lato, lateribus rectis, longitudine $1\frac{3}{8}$ latiore, carinula praehumerali deficiente; carinula marginali acuta, fere recta, carinula submarginali antice paulo divergente, postice subparallela nisi cum carina marginali conjuncta; in disci medio depressionibus duo indistinctis; sculptura disci subtili densaque. Scutello transversaliter carinato. Elytris longioribus, apice subtiliter denticulatis ac separate rotundatis, pube brevissima obscura indistinctaque tectis; pone medium prope suturam pilis aliquot auratis plus distinctis intermixtis; sculptura aspera, subtilissima. Antennis nigris, brevioribus ab articulo quarto (incl.) dentatis. Lobo gulari medio distincte emarginato; segmento anali integro, apice rotundato; segmento

[7] Philip. Journ. Sci. 18 (1921) 356.

abdominali primo in medio elevatione parva granuliforme ornato (♂). Abdomine pedibusque viridi-aeneis, nitidis, subtilissime punctatis et pube minutissima albida sparse pilosis. Unguiculis fortiter dentatis, dentibus intus non prominentibus. Primus tarsorum posticorum articulus longitudine fere tres sequentes adaequat.

Patria: Sulu Islands (coll. *Obenberger*). Long. 6 mm.

Color bright green; undersurface paler and more shining. A space along lateral margin and suture of elytra obscure. Head broad and convex, not broader than anterior margin of prothorax, with a linear impression in middle of front. Antennæ dark, blackish, serrate from fourth joint. Thorax large, with two feeble impressions in the middle and in the anterior angles. Prehumeral carina absent. Sculpture of prothorax very dense and fine, consisting of dense, slightly arcuate striæ. Elytra 2$\frac{2}{3}$ times as long as broad, having the greatest width behind the middle; regularly convex, very equally and finely granulate, separately rounded and very finely denticulate at apex. Pubescence of elytra dark, not very distinct; only in apical and sutural region some paler and yellowish hairs are intermingled. Undersurface convex, covered with very short, fine, sparse, white pilosity. First abdominal segment (male) armed with a small, granuliform but very distinct elevation.

In my own collection is one specimen of this species, labeled as cited. Although it does not belong with the Buprestidæ sent by Baker, it is important to describe it with the other Philippine forms.

Agrilus subvittatus Fisher. Plate 2, fig. 18; Plate 3, fig. 34.

The present specimens are from Dapitan, Mindanao; also one specimen from Basilan Island (*Baker*).

Agrilus orientis sp. nov. Plate 2, fig. 28; Plate 4, fig. 18.

Viridi-aeneus, robustus, curtulus, elongatus, obscurus, minute ac rugose sculptus, parum nitens. Capite obscure viridi-aeneo, convexo, medio sulcato, fronte transverse, dense ac satis fortiter rugosa, antennis viridibus, ab articulo quarto dentatis. Fronte satis lata, lateribus leviter rotundatis. Thorace lato, longitudine fere 1$\frac{2}{3}$ latiore, lateribus leviter rotundatis, ad basim paulo plus attenuatis, in medio latitudine maxima; sculptura transversa rudissima sed subtili densissima haud nitidus. Carina praehumerali deficiente seu perparum distincta, carina laterali

leviter sinuata, carina submarginali paulo divergente, fortiter sinuata ac ne basi quidem cum illa laterali juncta; impressione parva circulari ante scutellum ac depressione obliqua in angulis anticis lateralibus. Gulari lobo distincte emarginato. Scutello transverse carinato. Elytris fortibus, abdomen totaliter tegentibus, convexis, pone medio paululo dilatatis, dein ad apicem attenuatis, ac ibi curte separatim rotundatis ac minutissime denticulatis. Sculptura minutissima, sed densissima, granulosissima ac rudi, transversali. Sine pube distincta; solum prope apicem sutura fascia tenuissima pilorum parum distinctorum alborum marginata est. Abdomine convexo, parum nitido, dense albo, curte pubescente. Abdominis segmento ultimo curte sed distinctissime emarginato.

Patria: Sulu Islands (coll. *Obenberger*). Long. 6 mm.

This species resembles in color *Agrilus angustulus* Illiger, of Europe, but it is very robust.

Head convex, with impressed longitudinal line. Front on sides finely feebly rounded, nearly glabrous, transversely distinctly granulate. Antennæ bronzy, dentate from fourth joint. Gular lobe distinctly emarginate. Prothorax broad, nearly $1\frac{2}{3}$ times as broad as long, with the greatest width in the middle, on sides moderately rounded, and toward base a little more attenuated; hind prehumeral carina absent, lateral carina feebly sinuate, submarginal carina anteriorly very distant from it, more strongly sinuate, posteriorly a little approximate to but not joined with lateral carina, and distant also in the hind angles. Elytra robust, roughly but very finely and densely sculptured, rounded at tip, nearly hairless, only the suture near apex with some white, silky, not very distinct hairs. Abdomen densely covered with fine white pubescence; last ventral segment shortly but very distinctly emarginate. Claws simply cleft, lower portion not turned inward.

Agrilus encaustus sp. nov. Plate 2, fig. 23; Plate 4, fig. 14.

Niger, subelongatus et subattenuatis. Capite parvo, parum convexo, vertice parum impresso; fronte attenuata, longa, lateribus subsinuatis. Antennis longioribus, opacis, ab articulo quarto (incl.) denticulatis. Articulis triangularibus, singulis latitudine longioribus. Pronoto convexo, longitudine $1\frac{1}{2}$ latiori, antice fortiter bisinuato, lobo medio valde proeminente; lateraliter largitudinem maximam prope angulos anticos attingente, dein ad basim sinuate attenuato et subcordiformi; rugis regula-

ribus transversalibus instructo. Carina praehumerali indistincta; carina marginali bene expressa, acuta et fere recta; carina submarginali cum carina marginali in angulis posticis conjuncta, angulos anticos versus valde divergente. Lobo gulari medio distincte sed parum profunde emarginato. Scutello carinato. Elytra longioribus, subattenuatis, subconvexis, disco modeste deplanatis, sicut alterae corporis superioris partes, glabris, solum in parte postica prope suturale pilis brevissimis albidis raris ac irregularibus ornatis. Apicibus separate rotundatis ac minutissime denticulatis. Abdominis segmento ultimo fortiter emarginato. Pedibus ac abdomine obscure viridi-aeneis, subnitidis. Unguiculis fortiter dentatis. Tarsorum posticorum articulus primus longitudine tres sequentes adaequat.

Patria: Sulu Islands (coll. *Obenberger*). Long. 5.8 mm.

This species is very remarkable for the deep black color and feeble luster of the upper surface and for the form of the gular and the anal emargination.

Head relatively small, without luster, plane, transversely striate, without pubescence; front very narrow with subsinuate sides; vertex distinctly impressed. Eyes not prominent. Prothorax subcordiform, having the greatest width at anterior angles; sides subsinuate and subattenuate to base. Without distinct depression on the middle; in the anterior angles more distinctly impressed. Scutellum distinctly transversely carinate. Elytra finely, equally, and densely rugose, feebly subdepressed on back; regularly narrowed to apices, the greatest width behind the middle. Lateral parts of abdomen entirely covered, not visible from above. Apices of elytra separately rounded and finely denticulate. On apical and sutural part of elytra a very indistinct, very short, fine, irregular, white pilosity. Undersurface paler and more shining than upper surface; gular emargination feeble, but very distinct; emargination of last ventral segment deep and strong. Tarsi short; first joint of posterior tarsi as long as the three following joints. Claws dentate, the teeth not convergent.

Agrilus fisheri nom. nov. Plate 2, fig. 17; Plate 3, fig. 33.

The name *fulvovittatus* Fisher being already employed by E. Saunders for a species from Japan, I must change it; I propose the name *fisheri*.

In the collection sent to me there were several specimens, all from Dapitan, Mindanao (*Baker*).

Agrilus harlequin sp. nov. Plate 2, fig. 4; Plate 3, fig. 20.

Nonnullis generis *Sambus* speciebus simillimus. Convexus, cylindricus, curtus, niger, modice nitidus, maculis densis pilorum fulvorum irregularibus; his pilis apice elytrorum fasciam transversam formantibus; inter hanc pilositatem prope suturam elytrorum nonnulis maculis albis intermixtis; quae pilositates ornamentum marmoratum efficiunt. Capite lato, convexo, fronte satis tenui, lateribus ad anticem paulo attenuatis, ac levissime sinuatis. Violacea, dense luteo, antice albido pilosa. Antennis nigris, ab articulo quarto dentatis. Thorace convexo, in quarta basali parte subparallelo, dein ad capitem fortiter, fere recte attenuato, transversim rugoso, ante scutellum paullo depresso, carina praehumerali curta ac convexa, carina laterali fere recta, carina submarginali in medio sinuata, antice divergente, in basi cum illa laterali juncta. Lobo gulari fortiter prominulo, rotundato, integro. Elytris convexis, curtis, robustis, pone medium dilatatis, dein fortiter attenuatis, apice separatim rotundatis ac denticulatis; usque ad $\frac{3}{5}$ longitudinis ornamento macularum fulvorum ac (prope suturam) albidarum, dein fascia obscura transversa denudata (sed tamen pube vix visibili nigra) parte apicali lutea; fascia illa obscura ad suturam macula minuta albida obliqua ornata. Abdomine convexo, aeneoviolaceo, densissime luteo pubescente. Segmento anali apice curtissime, sed distincte emarginato. Tarsis curtis; tarsorum posticorum articulo primo duo sequentes longitudine adaequante. Unguiculis fortiter, sed simpliciter dentatis, partibus internis haud inversis.

Patria: Borneo, Kinabalu (coll. *Obenberger*). Long. 4.5 mm.

I have a few specimens of this very remarkable species in my own collection. It is broad, short, narrowed to the caudal apex, and very convex.

Head, prothorax, and elytra very densely covered with yellow pubescence; in some places on elytra the pubescence is interrupted and so presents a marbled appearance; in the pubescence white spots are intermixed as also on thorax before the carinate scutellum and the small antescutellar depression; on elytra are some white spots near suture, forming an irregular, interrupted band. Ornamentation of elytra behind three-fifths of elytral length interrupted by a large, transverse, denuded fascia; in reality it is covered with very fine, black pilosity; there is a sutural oblique white spot; apex behind this obscure fascia entirely covered with dense yellow pubescence. Sculpture of elytra rather strong. Abdomen convex, very densely

covered with yellow pubescence; pubescence of prosternum more white. Last ventral segment at end very shortly and feebly but distinctly emarginate. Gular lobe entire. Claws simply but strongly cleft, lower portion not turned inward.

In ornamentation this species rather resembles some species of the genus *Sambus*, and differs in size and form from all the other Oriental species known to me.

Agrilus sandakanus sp. nov. Plate 2, fig. 37; Plate 3, fig. 38.

Cupreus, satis nitidus; supra obscuratus, parum nitens; capite lato, parum convexo, fronte lata, latitudine longitudinem fere adaequanti, lateribus subparallelis, paulo sinuatis, sculptura dense rugulosa, pube desuper brevi, recumbente, albida radiolari. Vertice parum impresso, dense longitudinaliter striato. Antennis cupreis, ab articulo quarto dentatis. Thorace longitudine $1\frac{1}{2}$ latiore, latitudinem in medio maximam attingente, dein ad apicem paulo, ad basim fortius sinuato-attenuato. Margine anteriori leviter bisinuato, lobo medio haud producto. Carina praehumerali longa, ad basim convexa, dein carinae laterali valde approximata ac cum ea parallela usque ad tertiam partem anteriorem distincta. Carina laterali fere recta, carina submarginali cum ea antice modice divergente in basi juncta. Thoracis lateribus (exclusive spatio inter carinae praehumeralem ac lateralem) pube curta densissimaque albida marginatis. Lobo gulari modice emarginato. Elytris subrobustis, pone medium levissime dilatatis, dein ad apicem attenuatis ac separatim rotundatis. Sculptura minutissima, densa; superficie tota pube brevissima, parum apparenti, luteola, huc ibique obscuriori tecta; inter hac pubescentia duo maculis ovalibus parvis albidis: una ad suturam ante tertiam partem anteriorem, altera in tertia parte posteriori prope suturam positis. Abdomine convexo, minute sculpto ac brevissime sparse pubescente. Partibus lateralibus pro-, meso- ac metasterni pube densissime albida ornatis. Ultimo abdominis segmento integro, rotundato. Tarsis curtis, tarsorum posticorum articulo primo duo sequentes longitudine adaequante. Unguiculis simpliciter dentatis.

Patria: Borneo, Sandakan (*Baker*). Long. 6 mm.

Cupreous, undersurface clearer and more shining. Upper surface obscurate, finely granulose, with two white spots on each elytron near suture. Convex, cylindric, relatively robust. Head broad, nearly as long as broad, on sides nearly parallel, feebly sinuate. Sculpture dense and rugose, covered with sparse, fine, recumbent white radial pilosity. Vertex feebly

depressed and densely longitudinally striate. Prothorax nearly 1.5 times as broad as long, the greatest width near the middle, anteriorly feebly rotundate, posteriorly rather strongly sinuate-attenuate to base. Prehumeral carina very long, in anterior part parallel and very approximate to lateral margins. Gular lobe distinctly emarginate. General sculpture of surface of prothorax fine and dense; disk with a transverse prescutellar depression, and with an oblique impression in the anterior angles. Scutellum transversely carinate. Elytra very finely sculptured, on sides nearly parallel, behind middle feebly enlarged and then narrowed moderately to apex, which is separately and finely rounded. Entire surface of elytra covered with fine, dense, very short, golden, in some places more obscurate and not very distinct pubescence. Two white spots on each elytron, one before the anterior, the other in apical third. Abdomen convex, shining, densely and finely haired; last ventral segment entire, not emarginate. Legs cupreous, tarsi short, first joint of posterior tarsi as long as the next two together. Claws simply cleft, lower portion not turned inward.

It is very interesting that this species is extremely near to another species of my collection from Key Islands, described below.

Agrilus xenius sp. nov. Plate 2, fig. 38; Plate 3, fig. 39.

Of the same size and coloration as the preceding species; differing from it as follows:

1. Head wider.
2. Prothorax wider, with more acute hind angles, laterally less narrowed to base and more sinuate. Prehumeral carina similar but longer, reaching to anterior fourth.
3. Elytra of similar form and sculpture but apically produced in a short but very acute, denticulate spine. The two white spots of *A. sandakanus* are replaced here by similar, golden spots, the anterior longer. Also in the humeral depression of elytra with golden pubescence.
4. Abdomen more densely pubescent; sides of abdominal segments between the yellow pubescence with a yellow spot.
5. Lateral parts of prosternum, mesosternum, and metasternum covered with dense yellow pubescence.

I have six specimens of this species in my collection; two are in the collection of Baron Houbek-Mühlheim. I have seen some specimens also in material from Staudinger and Bang-Haas, Dresden, sent to me for determination.

It is very interesting to find such affinity in two insects from localities so widely separated. The presence of a spine on the elytron in one of two such related forms is clear proof that this character cannot be used to divide the Agrili into natural groups and that it is of not greater than specific value.

Patria: Key Islands. Length, 6 to 7.5 millimeters.

Agrilus atratulus sp. nov. Plate 2, fig. 19; Plate 4, fig. 8.

Robustus, convexus, obscure cupreo-violaceus, lateribus thoracis ac vertice cuprescentibus, fronte viridi, smaragdinea. Subtus bronceus. Capite convexo, fronte lata, transverse rugoso, lateribus levissime rotundatis, fere rectis, antennis aureis, ab articulo quarto dentatis. Vertice impresso, longitudinaliter rugoso. Thorace convexo, longitudine 1½ latiori, in basi latissimo, ad anticem paulo, dein fortius rotundato-attenuato, antice leviter bisinuato, carina praehumerali convexa, curti, valde divergenti, forti, carina laterali fere recta, carina submarginali iam ante basim cum illa laterali juncta; disco convexo, ante basim transverse subtiliter impresso, depressione obliqua laterali in utroque angulo antico; transverse rugoso, in medio fascia indistincta pilorum albosericeorum; huc et ibi pilis nonnullis albosericeis. Scutello latissimo, transverse carinato. Gulari lobo modice emarginato. Elytris robustis, atratulis, obscure cupreo violaceis, subtiliter sculptis, lateraliter partes laterales abdominis haud obtectantibus, pube obscura indistincta, solum secundum suturam a basi usque ad medium fascia aequali pilorum albosericeorum; ibi hac fascia paulo dilatata ac ad elytrorum mediam producta, "sagittam" simulante. Una macula siunti alba prope suturam in parte quarta apicali. Abdomine aeneo, aequaliter sparse brevissime albo pubescente. Segmento ultimo apice breviter sed profunde emarginato. Unguiculis longe fissis.

Patria: Sulu Islands (coll. *Obenberger*). Long. 5.5 mm.

A broad, robust, convex species. Dark violaceous, with cupreous luster, sides of prothorax and vertex cupreous, front bright green. Head convex, front large, with transverse rugosity; sides nearly straight, feebly rotundate. Antennæ brassy green or golden, dentate from fourth joint. Vertex longitudinally impressed and very distinctly longitudinally striate. Prothorax broad, nearly 1.5 times as broad as long, the greatest width at base, at first feebly, then more strongly attenuate and rounded to apex. Prehumeral carina strongly developed, very

divergent from lateral carina; the two prehumeral carinæ of prothorax, observed from above, a little convergent to apex. Prothorax nearly hairless, only here and there with some white silky hairs; in the middle with a very fine, not very distinct, narrow, white longitudinal fascia. Gular lobe distinctly emarginate. Scutellum very large and strongly transversely carinate. Elytra finely sculptured, rather robust, convex, dark violaceous with very feeble cupreous luster, nearly hairless (in reality covered with a very inconspicuous and obscure pilosity); on each side of suture a longitudinal fascia, reaching to middle of elytra, there dilated transversely and a little obliquely, forming the figure of an arrow. A similar spot on suture in apical fourth part; apices rounded. Undersurface bronzy covered with very short, white pubescence. Last ventral segment shortly but deeply emarginate. Claws deeply bifid, lower portion turned inward feebly.

This species can be easily distinguished from other species of the Oriental Region by its form, sculpture, size, ornamentation, etc.

Agrilus oppositus sp. nov. Plate 3, fig. 9; Plate 4, fig. 6.

Aeneus, nitens, fronte antice et lateribus aurea, medio ac postice violacea, thorace violaceo. Elytris pube uniformi albida, pone medium fascia transversa denudata. Capite convexo, margine thoracis anteriore haud latiore, fronte satis lata, ad anticem paulo attenuata, lateribus paulo sinuatis ac concavis; fronte alutaceo, subtiliter transverse striato, medio longitudinaliter impresso. Vertice impresso, longitudinaliter minutissime striato. Antennis obscuris, ab articulo quarto (incl.) dentatis. Prothorace longitudine $1\frac{1}{3}$ latiore, prope medium latissimo, dein ad angulos anticos ac ad basim leviter rotundato. Carina praehumerali longa, parum convexa, cum carina marginali in medio longitudinis conjuncta, carina laterali fere recta, antice paulo declivi, carina submarginali cum ea antice divergente, in angulo basali conjuncta. Depressione transversa ante basim, impressione minore in angulis anticis thoracis. Rugis transversalibus, paulo recurvis. Lobo gulari integro, rotundato. Scutello transverso, carinato. Elytris longioribus, dorso subplanis, pone medium subdilatatis, dein fortiter attenuatis, apicibus singulariter rotundatis ac minutissime denticulatis; elytrorum superficie minute transverse granulosis, pilositate uniformi ac densa. Subtus convexus, nitidulus, abdomine minutissime punctato, curte sparse regulariterque albido piloso. Segmento anali

emarginato. Pygidio integro. Tarsorum posteriorum articulo primo longitudine tres sequentes adaequante. Unguiculis simpliciter fissis, dentibus internis non convergentibus.

Patria: Borneo, Sandakan (*Baker*). Long. 4.5 mm.

Æneous; prothorax and head violaceous; front laterally and in anterior part more æneous. Upper surface rather feebly shining. Form elongate, elytra subdepressed on back. Front rather large, a little convergent anteriorly, shagreened, with very fine transverse sculpture, preoral part pilose. Antennæ obscure and dentate from fourth joint. Gular lobe entire, not emarginate. Prosternum 1⅓ times as broad as long, the greatest width in the middle, laterally feebly rounded. Sculpture composed of fine, transverse, arcuate striæ, the intervals finely punctate. Scutellum transversely carinate. Elytra equal, rather depressed on back, the greatest width behind the middle and then attenuate to apices which are separately, narrowly rounded and finely denticulate; the elytra leave uncovered narrow margins of abdomen. Entire surface of elytra clothed with a very fine, regular, white pubescence, behind the middle interrupted in the form of a transverse fascia. Abdomen very finely punctured and clothed with short white pubescence. Last ventral segment largely emarginate. Claws simply cleft, the lower portion not turned inward.

Type in the Baker collection.

Agrilus microtatus sp. nov. Plate 3, fig. 12; Plate 4, fig. 5.

Aeneus, thorace olivaceo, lateribus viridibus; fronte smaragdinea. Elongatulus, subobesus, cylindricus, convexus. Capite convexo, lato, margine thoracis anteriore paululo latiore, fronte lata, parum convexa, smaragdinea, dense granulose transverse rugoso, pube brevissima albida sparsa, vertice obscurato, obscure aeneo, impresso, longitudinaliter striato, antennis viridibus, ab articulo quarto (incl.) dentatis, curtis. Thorace convexo, longitudine 1½ latiore, transverse fortiter rugoso. Thorace in parte anteriori tertia latissimo, dein ad basim brevissime subsinuato. Carinis praehumeralibus, desuper obscuratis, convergentibus; carinis his curtis, ab carina laterali utraque valde divergentibus. Carina submarginali ante basim cum carina laterali conjuncta, dein ad apicem paulo divergente. Lobo gulari emarginato. Scutello transverse carinato. Elytris convexis, subrobustis, pone medium paullulo dilatatis, dein ad apices modeste attenuatis, his separatim subangulosis, superficie haud dense transverse squamulosa, nitida, pube obscura tecta; solum

secundum suturam fascia lata pilorum albidorum ornata; hac pubescencia illa obscura haud densiore et pone medium atque ante apice transverse interrupta. Abdomen nitens, fere glabrum, ultimum abdominis segmentum apice curte sed profunde circulariter emarginatum. Tarsis curtis, unguiculis simpliciter dentatis.

Patria: Borneo, Sandakan (*Baker*). Long. 3.1 mm.

Æneous; prothorax more brassy green, sides greenish. Front bright green, head convex, very slightly broader than anterior margin of prothorax. Vertex feebly convex, very densely granulate and transversely rugose, with short, sparse, silky pubescence. Antennæ green, dentate from fourth joint. Prothorax 1.5 times wider than long, the greatest width in anterior third part, then very feebly sinuate to base. The two strong, short prehumeral carinæ, seen from above, anteriorly convergent. Sculpture of prothorax relatively strong, consisting of transverse striation. Gular lobe distinctly emarginate. Scutellum transversely carinate. Elytra robust, convex, æneous, shining, very slightly broadened behind the middle, then moderately attenuate to apices which are separately rounded and subangulate at tip; the rounded obtuse tip situated near suture. Entire surface of elytra covered with fine, short, obscure pilosity; only along suture on each side is there a large fascia, composed of fine, silky, white hairs; this fascia twice interrupted behind the middle and on apex. Undersurface shining, with extremely fine sculpture, last ventral segment with short but deep semicircular emargination at tip. Legs and tarsi short, claws simply cleft, lower portion not turned inward.

This species is very remarkable because of the size, form, and ornamentation of the elytra and the form of the last ventral segment. Type in the Baker collection.

Agrilus operosus sp. nov. Plate 2, fig. 29; Plate 4, fig. 19.

Speciei europeae *Agrilo derasofasciato* Ksw. similis. Capite convexo, fronte longitudinaliter impressa, antice virescènte, alutacea, sine sculptura alia distincta, vertice cupreo, fortiter impresso, leviter longitudinaliter striato, antennis virescentibus, longioribus ab articulo quarto dentatis; thorace in parte octavo anteriori latissimo, dein ad basim sinuato, depressione oblique laterali ac impressione forti, lata, praebasali; cupreo, nitido, sculptura haud densa rugarum subtilium, carina praehumerali usque ad medium thoracis longitudinis distincta, hic cum carina laterali juncta, *omnino ei maxime approximata, ad cum ea para-*

llela, carina laterali brevissime sinuata, fere recta, carina submarginali antice divergente, in basi cum ea conjuncta. Scutello transversim carinato. Lobo gulari antice emarginato. Elytris longis, aeneis, nitidis, sculptura subtili rugarum transversalium; lateribus fere rectis, pone medium leviter dilatatis, dein ad apicem fortiter attenuatis ac apicibus separatim rotundatis ac minutissime denticulatis. Superficie elytrorum pube brevi albida aequali tecta, fascia praeapicali transversa interrupta, glabra; etiam in parte basali ac laterali elytrorum fere glabra. Pedibus aeneis, articulo tarsorum posteriorum primo tres sequentes longitudine adaequante. Unguiculis simpliciter dentatis. Abdomine convexo, aeneo, segmento anali apice emarginato.

Patria: Borneo, Kinabalu (coll. *Obenberger*). Long. 5 mm.

This species resembles some species of the group of the European *A. derasofasciatus* Ksw. and many other species of the Oriental fauna.

Head cupreous, convex, front golden, vertex shagreened, without other distinct sculpture, longitudinally impressed on the middle, the impression still more pronounced on vertex which is finely longitudinally striate. Thorax rather narrow, cupreous, $1\frac{1}{3}$ times as broad as long, anterior margin strongly bisinuate, the greatest width in anterior eighth part; from this point thorax is rather narrowed and feebly sinuate to base. Prehumeral carina long, reaching to middle of lateral carina, nearly straight, extremely near to lateral carina anteriorly, and basally joined with it. Gular lobe distinctly emarginate. Scutellum transversely carinate. Elytra similar to *A. derasofasciatus,* æneous, shining, paler than prothorax which is more cupreous with darker preapical denudate fascia. Pygidium distinctly carinate, but the carina not lineately prolonged at tip (as for example in *A. pictithorax* sp. nov., or *A. albogaster* Deyrolle, which are of the same group). Last ventral segment emarginate at tip. Abdomen æneous, shining, finely sculptured, and pilose. Tarsi rather long, first joint of posterior tarsi as long as the three following together. Claws simply cleft, lower portion not turned inward.

In its group this species is very well distinguished by the long prehumeral carina, which is nearly parallel with the lateral carina.

Agrilus singaporensis sp. nov. Plate 3, figs. 1, 42.

Capite thoraceque smaragdineus elytris antice viridi-obscuris, dein obscurioribus, vitta postica subsuturali subsinuata ac lutea.

Capite lato, convexo, oculis paulo prominulis, fronte lata, lateribus subtilissime subsinuatis, fere glabra, transverse rugosa. Vertice rugoso, convexo, sine impressione media. Thorace latitudine $1\frac{1}{3}$ latiori, lateribus subrotundatis, in medio latissimo, dein ad apicem et ad basim attenuatis. Thorace subtiliter transverse rugosis; carina praehumerali paullo distincta, curta, carina marginali leviter curvata, carina submarginali cum illa antice fere subparallela, postice, pone medium, convergente et in angulis basalibus conjuncta. Lobo gulari distincto rotundato. Scutello lato, carinato. Elytris convexis, pone medium subdilatatis, dein ad apicem attenuatis, hic rotundatis ac minutissime denticulatis; abdominis partibus lateralibus pone medium elytrorum largitudinem superantibus. Sculptura elytrorum subtilissima aequalique; pone medium vitta lutea subsuturali; haec vitta in quarta parte apicali suturae valde approximata est. Abdomine convexo, aequali, subtilissime punctato, ultimo segmento integro, apice rotundato. Tarsis curtis; tarsis posterioribus $\frac{2}{3}$ tibiae posterioris attingentibus; articulo tarsorum posteriorum primo tres sequentes longitudine attingente.

Patria: Singapore (*Baker*). Long. 6 mm.

Convex, elongate. Head and prothorax bright green; elytra darker, without luster, and obscurate toward apex. Head broad, eyes a little prominent laterally. Front large, glabrous, densely and transversely striate, without luster, and with parallel sides. Vertex convex, densely striate, without impression. Prothorax 1.5 times broader than long, the greatest width in the middle, subrotundate at sides. Prehumeral carina not pronounced; marginal and submarginal carinæ very near together and nearly parallel in anterior middle. Gular lobe broadly rounded. Scutellum transversely carinate. The general form of elytra resembles *A. viridis* L., enlarged behind the middle, attenuate and separately rounded at apex, which is finely denticulate; without any discal impression; behind middle a subsinuate yellow sutural vitta; posteriorly more distant from suture; in last fourth nearer suture; surface not impressed. Undersurface convex, finely punctate, more shining; last ventral segment rounded at tip. Antennæ brassy green, dentate from fourth joint; first joint of hind tarsi as long as the three following joints together. Claws cleft in such a manner that the lower portion is turned inward, nearly touching that of opposite side.

Agrilus tardulus sp. nov. Plate 2, fig. 31; Plate 4, fig. 21.

Obscure aeneus, viridimicans, elongatus, cylindricus, convexus, staturae ac colore *Agrili angustuli* Illiger europaei simillimus. Capite lata, virescenti, alutaceo, latitudine marginem thoracis anteriorem paulo superante, fronte lata, alutacea, lateribus paralleli, subtiliter transverse rugosa, antice albo pubescente, antennis viridi-aeneis, ab articulo quarto dentatis, satis curtis. Thorace longitudine 1½ latiore, lateribus modice rotundatis, latitudine maxima in medio; margine antico modice bisinuato, sculptura satis densa ac satis forte rugarum transversalium; carina praehumerali longa, modice convexa, antice in medio longitudinis cum illa laterali juncta; hac carina fere recta, carina submarginali antice divergente, baseos iam ante basim cum carina laterali juncta. Gulari lobo distincte emarginato. Elytris longiusculis, pone medium leviter dilatatis, dein ad apicem attenuatis ac ibi separatim, satis late rotundatis ac minute denticulatis; elytrorum superficie tota pube brevi, sparsa, albida, regulari ac aequali tecta; solum lateraliter in parte anteriori hac pubescentia minus distincta. Scutello transversim carinato. Abdomine convexo, apice segmentis anali rotundato, nitido, obscure viridi-aeneo, fere glabro. Femoribus viridiscentibus, tarsorum posticorum articulo primo duo sequentes longitudine adaequante. Unguiculis simpliciter dentatis.

Patria: Sulu Islands (coll. *Obenberger*). Long. 4.5 mm.

This species resembles very much some European species. Color and form nearly as in *A. angustulus* Illiger, pubescence of elytra nearly as in A. *olivicolor* Illiger. Dark æneous, rather shining, with greenish luster. Elongate, cylindrical, convex; head broad, a little broader than anterior margin of prothorax. Front greenish, shagreened, transversely and finely rugose. Vertex feebly impressed and longitudinally, densely striate. Sides of front parallel. Antennæ greenish, æneous, dentate from fourth joint. Prothorax nearly 1.5 times as broad as long, the greatest width in the middle, moderately rounded on sides, glabrous, with rather strong transverse sculpture. Prehumeral carina long, rather convex, feebly sinuate anteriorly, where it is joined to lateral carina nearly in the middle of the length of lateral carina. Gular lobe distinctly emarginate. Elytra moderately dilated behind middle, then narrowed to end, where they are separately rounded and minutely denticulate. Entire surface

covered with very fine, very short, equal, silky, white pubescence; this pilosity is only less distinct anteriorly on sides. Abdomen dark æneous, shining, very finely sculptured; last ventral segment rounded at tip. Legs greenish, bronzy; first joint of posterior tarsi as long as the next two together. Claws simply cleft, lower portion not turned inward.

Agrilus pilipennis sp. nov. Plate 3, fig. 4; Plate 4, fig. 1.

Bronceus, nitidulus, elongatus. Capite subconvexo, lato, oculis lateraliter haud prominentibus, fronte lata, cuprea, haud convexa, marginibus subparallelis, levissime subsinuatis, alutacea, rugis aliquot circularibus indistincte indicatis, antice aureola, pilis nonnulis aureis. Vertice impresso, subtilissime longitudinaliter striato. Antennis aeneo-viridibus, ab articulo quarto (incl.) dentatis. Prothorace longitudine 1⅓ latiore, margine antico modice bisinuato, latitudinem maximam in quinta parte anteriore attingente, dein ad basim fere recta attenuato, angulis posticis fere rectis. Sculptura striarum transversalium subtilium; harum intervallis alutaceis ac minutissime sparsim punctatis. Carina praehumerali convexa, forti curtaque; carina laterali fere recta, carina submarginali cum ea antice valde divergente, baseos conjuncta. Lobo gulari emarginato. Elytris longis, pone medium levissime dilatatis ac ibi abdominis partem lateriorem haut obtectantibus, dein ad apices modeste attenuatis; apicibus singulatim anguste rotundatis ac minutissime denticulatis, carina humerali recta usque ad tertiam partem anteriorem distincta. Elytrorum sculptura squamiformi transversa minutissima; superficie tota densissime aequaliterque pube brevi aurea tecta; haec pubes solum lateribus exterioribus, parum obscuratis haud distincta est. Subtus convexus, nitidus, abdomine minutissime punctato ac pube brevissima albida aequaliter tecto. Abdominis segmento ultimo truncato. Tarsis curtis; tarsorum posticorum articulo primo longitudine tres sequentes adaequante. Unguiculis simpliciter dentatis.

Patria: Borneo, Sandakan (*Baker*). Long. 5 mm.

This species resembles in general form *A. roscidus* Ksw. of Europe.

Small, elongate, æneous; head broad, but not broader than anterior margin of prothorax; front relatively broad, sides nearly parallel, very feebly sinuate; the middle of front nearly without sculpture, being very distinctly shagreened with some very feebly indicated circular striæ on sides. Anterior part of head more golden, with golden pilosity. Vertex impressed longitudinally

and finely longitudinally striate. Thorax 1⅓ times broader than long, the greatest width in anterior fifth part, then to base nearly straightly narrowed, with rectangular basal angles. Sculpture consisting of fine, transverse, not very dense striation; the intervals between striæ very distinctly shagreened, and sparsely, very finely punctured. Gular lobe emarginate. Scutellum transversely carinate. Elytra elongate, parallel to behind the middle, where they are moderately broadened; lateral margins of first abdominal tergite exposed; elytral apices finely denticulate and narrowly rotundate. From humeri passes a distinct straight carina to anterior third. Sculpture of elytra very fine, entire surface with exception of extreme lateral margins, which are a little obscurate, covered with fine, golden, short, equal pubescence. Abdomen convex, shining, with very fine sculpture and with very short, regular, white pilosity. Last ventral segment truncate. Tarsi short; first joint of posterior tarsi as long as the three following together. Claws simply cleft, lower portion not turned inward.

The single type, taken at Sandakan, is in the Baker collection.

Agrilus uniformipubis sp. nov. Plate 3, fig. 5; Plate 4, fig. 2.

Species parva affinitatis *Agrili moultonis* Kerremans. Cupreoviolaceus, elytris violaceis, parum nitens, subtus nitidior, cupreus. Parvus, subelongatus, capite lato, viridi, dense transversim granulose-rugoso, vertice cupreo, levissime canaliculato, dense longitudinaliter striato. Frontis lateribus sinuatis, fronte lata. Antennis viridibus, ab articulo quarto dentatis. Gulari lobo leviter, curte emarginato. Prothorace lato, transverso, longitudine fere 1⅗ latiore, lateribus in quinta parte anteriori latitudinem maximam attingentibus, dein ad basim modice sinuatis. Disco subtiliter transversim, haud dense striato, impressione transversa lata praebasali ac alia in utroque angulo antico. Carina praehumerali longa, prolongata, tertiam partem anteriorem longitudinis attingente, convexa, in parte anteriori carinae laterali valde approximata ac cum ea conjuncta. Carina laterali fere recta, carina submarginali antice valde divergente. Dein ante basim subito approximata ac in basi cum illa laterali juncta. Scutello transversim carinato. Elytris aequalibus, dorsa subplanis, pone medium dilatatis, dein ad apicem attenuatis ac ibi separatim rotundatis ac denticulatis. Sculptura elytrorum granulosa ac minutissima, densissima. Superficie elytrorum tota pube brevi, albida, curta ac densa tecta. Pedibus cupreis, femoribus mediis virescentibus, tarsorum posteriorum articulo

primo tres sequentes longitudine adaequante. Abdomine convexo, aequaliter albide piloso. Partibus lateralibus pro-, meso-, ac metasterni densius albide pubescentibus. Segmento anali apice integro, rotundato. Unguiculis simpliciter dentatis.

Patria: Sandakan, Borneo (*Baker*). Long. 5.5 mm.

This species resembles very much some specimens of *Agrilus roscidus* Ksw.

Elongate, rather robust, and depressed. Head wide, but not broader than anterior margin of prothorax. Front broad, green, plane, laterally sinuate; very densely transversely rugose. Vertex very feebly impressed on the middle, very densely longitudinally striate, and cupreous. Antennæ rather long, green, dentate from fourth joint. Prothorax broad, the greatest width in anterior fifth part, then moderately sinuate to base; with very large, not deep, but very distinct transverse depression before base; an oblique impression on each side in anterior angles. Prehumeral carina very long, entire, sinuate, anteriorly very near to lateral carina and in anterior third part joined with it. Scutellum transversely carinate. Gular lobe very shortly and not distinctly emarginate. Elytra rather long, rather depressed on back, laterally feebly sinuate and nearly parallel, moderately dilated behind middle and narrowed to apices, which are separately rounded and finely denticulate. Without humeral carina, the lateral parts of abdomen near the middle not entirely covered by elytra. Elytral sculpture a very dense and extremely fine granulation; entire surface covered with short, dense, equal, white, fine pubescence. Abdomen more shining, convex, left ventral segment entire. Tarsi rather short, legs cupreous, only the middle femora greenish. First joint of hind tarsi as long as the three following together. Claws simply cleft, lower portion not turned inward.

Agrilus pilistoma sp. nov. Plate 2, fig. 10; Plate 3, fig. 26.

Obscure nigro-aeneus, metallicus, capite coerulescente, thorace obscure cupreo-aeneo. Capite convexo, marginis thoracis anterioris vix latiore; fronte alutacea, coerulescente, impunctata, glabra; parte praeorali albido pilosa. Antennis obscuris, ab articulo quarto (incl.) denticulatis. Thorace longitudine paullo latiore, margine antico bisinuato, lobo medio modice producto; sculptura rugarum transversalium subtilium ac regularium; depressione modesta in angulis anticis. Carina praehumerali longa, parum convexa, cum carina laterali prope medium longi-

tudinis conjuncta. Carina laterali recta, carina submarginali baseos cum carina laterali conjuncta, antice modice divergente. Lobo gulari emarginato. Scutello transverse carinato. Elytris convexiusculis, elongatis, pone medium paulo dilatatis, dein ad apicem attenuatis et ibi separatim rotundatis ac minute punctulatis. Sculptura elytrorum minuta ac aspera, rugas transversales indistinctas efficiente. Tota elytrorum superficie pube brevi, densa, aequali, fulva ornata; haec pubescentia solum ad partes laterales, secundum margines minus distincta est; ibi pili curtissimi obscuri observantur. Abdomine ac corpore subtus nitidiore, aeneo. Abdomine convexo, minute sparse punctato pube sparsa curtissimaque; ultimo abdominis segmento integro, rotundato. Tarsorum posticorum articulo primo sequentes tres longitudine superante. Unguiculis simpliciter fissis, partibus interioribus unguiculorum non convergentibus.

Patria: Sulu Islands (coll. *Obenberger*). Long. 5 mm. (♂).

Elongate; very dark æneous. Head shagreened, without other sculpture, glabrous; preoral part of front covered with fine white pubescence. Front relatively broad, lateral margin anteriorly feebly convergent. Eyes laterally not prominent. Prothorax relatively long, being only a little broader than long, anterior margin bisinuate; median lobe moderately advanced toward head. Thorax sinuate, and moderately attenuate to base, the greatest width in anterior third. Sculpture regular and relatively fine. Gular lobe distinctly emarginate. Scutellum transversely carinate. Elytra long, a little enlarged behind middle, then attenuate to apex, where they are separately rounded and finely denticulate; entire surface covered with fine, regular, short, yellowish pubescence; this is indistinct only along sides in a small longitudinal space, being replaced here by similar but shorter and very obscure pilosity. Pygidium without carina. Abdomen convex, finely and sparsely punctured, and with short, sparse, white pubescence, more shining than upper surface, æneous. Last ventral segment rounded at tip. First joint of posterior tarsi as long as the three following joints together. Claws simply cleft, lower portion not inverted.

Agrilus manilensis Fisher. Plate 2, fig. 21; Plate 4, fig. 10.

In the species sent to me from the Baker collection were two (female and male) specimens of this species coming from Basilan Island.

Agrilus luctuosellus sp. nov. Plate 2, fig 8; Plate 3, fig. 24.

Cupreo-aeneus, thorace ac capite cupreis, subtus obscure aeneus. Capite convexo, margine anteriore thoracis non latiore. Fronte lata, lateribus subparallelis, transverse subtiliter striata. Antennis obscure aeneis, ab articulo quarto (incl.) dentatis. Vertice longitudinaliter impresso. Thorace longitudine 1⅓ latiore, margine antico bisinuato, lobo medio producto, latitudinem maximam in parte tertia anteriori attingente, dein ad basim fortices quam ad angulos antices, leviter sinuato-attenuato. Rugis transversalibus subtilibus, regularibus. Carina praehumerali distincta, paulo convexa, in longitudinis dimidio cum carina laterali conjuncta. Carina laterali fere recta, carina submarginali in angulis posticis cum c. laterali conjuncta, dein cum illa paullo divergente, antice fere subparallela. Lobo gulari integro, rotundato. Scutello transverso, carinato. Elytris pone medium paullo dilatatis convexis, dorso subdeplanatis, ad apicem attenuatis,' hic separatim rotundatis ac minute denticulatis. Superficie elytrorum pube brevi albida aequali tectis, hac pube pone medium fascia tenui transversa denudata. Sculptura elytrorum densa minutaque. Subtus convexus, metallicus, fere impunctatus; pube sparsa curta albida. Segmentum anale apice subtruncatum, non emarginatum. Unguiculi?

Patria: Sulu Islands (coll. *Obenberger*). Long. 4.5 mm.

Small, elongate; coppery æneous with darker prothorax and head. Head convex, but not broader than anterior margin of prothorax, front relatively broad and parallel, with linear impressed inner margins of eyes in the form of a narrowed channel, very finely transversely striate, surface shagreened. Prothorax 1⅓ times broader than long, anterior margin bisinuate; median lobe extended. Sides of prothorax from anterior third part attenuate and feebly sinuate to base; hind angles acute. Sculpture of prothorax regular and fine, not very close. Gular lobe entire, rounded. Elytra elongate, a little enlarged behind middle, then attenuate to apices which are separately rounded and finely denticulate. The lateral parts of first abdominal segment are visible from above as they are not entirely covered by elytra. Sculpture of elytra fine and dense, consisting of transverse rugæ; surface entirely covered with fine, short, white, regular pilosity, this pubescence behind the middle interrupted by a transverse, narrow fascia which is without white hairs, only with short, obscure, sparse hairs. Undersurface darker but more shining, abdomen convex, nearly without punctuation, with short, sparse

pilosity. Last ventral segment broadly truncate, not emarginate.

My single specimen is defective and I could not see the form of the claws, but from the indicated characters it is new and different from all similar species of the Malayan fauna.

Agrilus ludificator sp. nov. Plate 2, fig. 32; Plate 4, fig. 22.

Elongatus, subcylindricus, convexus, obscure viridi-aeneus, nitens. Capite glabro, lato, thoracis marginis anterioris paulo latiore, lateraliter modeste proeminente; fronte lata, subplana, transverse rugosa, lateribus fere rectis, antice at ad latera pube tenuissima albida ornato. Vertice subtiliter impresso, longitudinaliter striato. Thorace longitudine fere 1½ latiore, antice bisinuato, lateribus satis fortiter rotundatis, latitudine maxima in medio, depressione minuta circulari ante scutellum, unaque obliqua in utroque angulo anteriore; superficie glabra, nitida, rugatione transversa, satis forti. Carina praehumerali parum convexa, antice sinuata, usque ad medium carinae lateralis distincta ibique cum ea juncta. Carina submarginali antice divergente, postice iam in tertia parte basali longitudinis cum illa laterali juncta. Gulari lobo parum producto, subtruncato. Scutello transversim carinato; elytris convexis, pone medium dilatatis, dein ad apicem attenuatis ac separatim rotundatis, minute denticulatis, sculptura satis forti transversa, rugosa; superficie glabra, solum secundum suturam in parte apicali fascia longitudinali (haud impressa!) pilorum sparsorum ac curtissimorum, albidorum, parum distincta. Abdomine, pedibus, antennisque aeneis; antennis ab articulo quarto dentatis, curtis, tenuibus, pedibus satis longis, tarsis curtis, tarsorum posticorum articulo primo tres sequentes longitudine adaequante. Unguiculis simpliciter dentatis. Segmento anali apice rotundato ac paululo acuminato.

Patria: Sulu Islands (coll. *Obenberger*). Long. 4 mm.

This species resembles *A. olivicolor* Illiger, of Europe, in color.

Convex, cylindrical, dark æneous, with greenish luster, rather shining. Head convex, a little broader than anterior margin of prothorax. Front broad, rather plane, with transverse rugosities; margins of front nearly parallel and straight. Vertex feebly impressed, longitudinally striate. Prothorax 1.5 times as broad as long, the greatest width in the middle, with rather strongly rounded sides; sculpture transverse, glabrous, rather strong, shining. A small rounded impression before scutellum

and on each side an oblique impression within anterior margin of prothorax. Prehumeral carina long, not very convex, rather near to lateral carina and joined to it in the middle, where it is a little sinuate. Gular lobe feebly extended, nearly truncate. Scutellum transversely carinate. Elytra rather convex, shining, rather strongly transversely rugose, nearly glabrous, only along suture with a rather large but very indistinct longitudinal fascia composed of extremely short, silky, white, sparse hairs, this fascia distinct only in apical part; in basal third part it is indistinct. Elytra dilated behind middle and then attenuate to apex, which is separately broadly rounded and dentate. Abdomen rather convex, shining; last ventral segment rounded and a little acuminate at tip. Antennæ, legs, and underside bronzy with green luster, tarsi obscure, first joint of posterior tarsi as long as the three following together. Claws simply cleft, lower portion not turned inward.

Agrilus carinipennis sp. nov. Plate 3, fig. 7; Plate 4, fig. 11.

Affinitatis *A. sepulchralis* H. Deyrolle.

Niger, nitidus, pedibus viridibus, fronte cyaneo-viridi, elytris dorso subplanis, carinatis. Capite alutaceo, convexo, fronte tenui, lateribus parallelis, in medio impunctata, antice transverse dense striata ac pilis aureis ornata, vertice impresso, longitudinaliter subtiliter striato, antennis viridi-aeneis, ab articulo quarto dentatis. Thorace longitudine $1\frac{1}{3}$ latiore, lateribus parallelis, carina praehumerali curta, forti, carina laterali fere recta, carina submarginali leviter sinuata ac cum illa in angulis basalibus conjuncta. Depressione rotundata antescutellari, atque impressione obliqua in angulis anticis. Sculptura transversa subtiliore; disco obscure, vix distincte pubescente. Lobo gulari integro, rotundato. Scutello transverse carinato. Elytris curtis, usque pone medium subparallelis, dein ad apicem modice attenuatis; apicibus separatim rotundatis ac minutissime denticulatis. Carina humerali recta usque ad $\frac{2}{5}$ longitudinis distincta. Superficie obscure pubescente; solum in medio fascia pilorum alborum lata transversa atque apicibus similiter ornatis. Abdomen nigrum, nitidum; segmentum abdominis ultimum minute sparse granulatum ac integrum. Tarsis curtis, articulo tarsorum posticorum primo longitudine sequentes tres adaequante. Unguiculis simpliciter dentatis.

♂ : Granulis duo approximatis segmentis primi basi.

Patria: Singapore (*Baker*). Long. 4 mm.

Black; rather robust. Head bluish green, shagreened; front laterally parallel; anteriorly covered with fine golden pilosity; vertex impressed and longitudinally striate. Prothorax with nearly parallel sides, black, covered with indistinct, obscure pilosity; with feeble circular depression before scutellum and with oblique impression on base. Sculpture rather fine. Gular lobe rotundate, entire. Elytra black, with fine sculpture, parallel on sides as far as to behind middle, and then narrowed to apex; this is separately rotundate and very feebly denticulate. Elytra, between the two humeral carinæ, subplanate, a little depressed; entire surface covered with obscure, not very distinct pilosity; behind middle occurs a large transverse fascia of white pubescence; apices also clothed with pilosity. Humeral carina of elytra sharp and straight, reaching to two-fifths of elytral length. Abdomen black, with a very fine sculpturation, metallic, with sparse and extremely fine, short, white pubescence. Legs green; tarsi short; first joint of hind tarsi as long as the three following together. Last ventral segment truncate, and with sparse, fine granulation. Claws simply cleft, lower portion not turned inward.

Male.—With two approximate granulæ on base of first abdominal segment. Very distinct because of sculpture and color. The single type is in the Baker collection.

Agrilus persolitarius sp. nov. Plate 3, fig. 11; Plate 4, fig. 4.

Capite coeruleo, vertice nigro, thorace nigro, lateribus viridimicante, elytris nigris, dense aureopilosis, subtus obscureaeneus, micans. Capite convexo, fronte lata, convexa, grosse punctata, antice aureopilosa, pilis longioribus; vertice nigro, impresso. Antennis viridicoeruleis, curtis, ab articulo quarto (incl.) dentatis. Prothorace longitudine $1\frac{1}{2}$ latiore, in medio longitudinis latitudinem maximam attingente, lateribus levissime rotundatis, fere rectis; depressione transversa praebasali; carina praehumerali curta; carina marginali fere recta levissime sinuata, carina submarginali cum ea subparallela ac valde approximata, in angulis posticis cum ea conjuncta. Sculptura rugarum transversalium subtili, micante. Lobo gulari integro, rotundato. Scutello transverse carinato. Elytris curtis, dorso deplanatis, usque pone medium subparallelis, ibi paullo subdilatatis, dein ad apices modice attenuatis, apicibus separatim rotundatim ac minutissime denticulatis; lateraliter carina elytrali humerali longa ac recta ornatis; haec carina usque ante medium

distincta est et ibi fere marginem lateralem attingit. Elytrorum superficie pube aurea densa aequali tecta; haec pubes pilis longioribus composita est. In parte apicali tertia pubescentia haec macula parva transversali ovali obscura interrupta est. Sculptura elytrorum minuta, granulosa, transversali. Abdomine convexo, nitido, minutissime punctato, segmento anali apice emarginato. Tarsorum posticorum articulus primus longitudine sequentes duo adaequat. Unguiculis simplice dentatis.

Patria: Singapore (*Baker*). Long. 3.2 mm.

A small, short, dark species. Head blue, vertex blackish. Sculpture of head rough; anterior half of head covered with long yellow pubescence. Vertex longitudinally impressed. Antennæ bluish green, dentate from fourth joint. Prothorax 1.5 times wider than long, the greatest width in the middle, on sides very feebly rounded, nearly straight. Prothorax shining, black; only sides with bluish or greenish luster. Gular lobe rounded and entire. Scutellum transversely carinate. Elytra short and relatively broad, laterally subparallel as far as to behind middle, then very little enlarged and moderately attenuate to apex; apices separately rounded and very finely denticulate. Disk of elytra plane; laterally with a very sharp, straight humeral carina which is long, reaching nearly to middle and here very near to lateral margin, but not joined to it. Sculpture of elytra fine; entire surface covered with a yellow equal pubescence which consists of rather long fine hairs; this pubescence is interrupted in apical third by a small transverse denudate macula, which is covered with dark, obscure, short pilosity. Abdomen convex, finely punctured, with fine white pubescence. Last ventral segment emarginate at tip. First joint of posterior tarsi as long as the three following together. Claws simply cleft, lower portion not inverted.

This species is very remarkable in consequence of the color, clear golden pilosity of the upper surface, the long elytral carina, etc. Type in the Baker collection.

Agrilus carinellifer sp. nov. Plate 2, fig. 35; Plate 4, fig. 25.

Parvus, aeneus, elongatulus, elytris dorso subdeplanatis. Capite convexiusculo, margine thoracis anteriore haud latiore; fronte subparallela, angusta, antice luteo pilosa, alutacea, sine rugis transversalibus. Vertice longitudinaliter impresso, subtilissime longitudinaliter striato. Oculis lateraliter haud prominulis. Thorace longitudine $1\frac{1}{2}$ latiore, convexo, antice bisinuato,

lobo medio modice producto, sculptura rugorum transversalium haud densarum ac subtilium. Lateribus paulo subrotundatis, ad basim modice sinuatis, latitudine prope medium maxima. Carina praehumerali curta, recta, cum illa laterali divergente; carina laterali recta, carina submarginali cum illa antice valde convergente, baseos conjuncta, recta. Lobo gulari late rotundato, integro. Scutello transverse carinato. Elytris dorso subdeplanatis, pone medium paulo dilatatis, dein ad apices modice attenuatis, ibique separatim rotundatis ac denticulatis. Elytris carina humerali, desuper visibili recta, usque pone tertiam anteriorem partem distincta ornatis. Sculptura elytrorum squamiformi haut densa, rugas transversales irregulares efficiente. Superficie elytrorum tota pube aequali sparsa albida vel lutescente tecta; solum pone medium spatio rotundo; minore, suturali, transverso, denudato. Subtus aeneus, nitidus; segmento anali apice curte sed profunde angulatim emarginato. Tarsis longioribus; tarsorum posteriorum articulo primo tres sequentes longitudine adaequante. Unguiculis simpliciter fissis.

Patria: Basilan Island (*Baker*). Long. 3.2 mm.

Small, æneous, elongate species. Surface æneous, moderately shining; head golden (female) or bluish green (male). Head convex, but not broader than anterior margin of prothorax. Front shagreened, without any puncturation or rugosity; anteriorly with yellow pilosity; laterally nearly parallel; vertex very finely, longitudinally striate, and impressed in middle; antennæ greenish, serrate from fourth joint. Prothorax 1.5 times as broad as long, with fine and rather sparse transverse rugosities; greatest width near the middle; sides feebly rotundate and attenuate to base and to apex. Gular lobe very convex and prominent but entire, without emargination. Scutellum transversely carinate. Elytra rather broad elongate, subdepressed on back between the humeral carinæ which are visible from above and parallel, reaching behind anterior third and very sharp and straight. Elytra subparallel to behind middle, then moderately and straightly attenuate to apices, which are separately rounded and denticulate. Sculpture consists of rather sparse, squamiform, transverse rugosity. Entire surface clothed with fine, silky, white pubescence; only behind middle a little oval transverse space is hairless. Undersurface finely punctured and moderately convex; last ventral segment shortly but very deeply angulately emarginate. Tarsi relatively long, first joint of

hind tarsi as long as the three following together. Claws simply cleft, lower portion not turned inward.

Male.—Head green, middle of prosternum covered with fine, dense, erect, white pilosity.

Agrilus pulcher E. Saunders.

In Fisher's paper[8] this species is cited in the key and in the annotations as being described by Deyrolle. In reality E. Saunders is the author who described the species in 1874.[9]

Agrilus pterochlorus sp. nov. Plate 2, fig. 27; Plate 3, fig. 16.

Aeneus, aureomicans, elongatus, convexus. Capite convexo, fronte lateribus subparallelis, in medio alutacea, minute punctata, antice pube aureola. Vertice impresso subtiliter longitudinaliter striato. Antennis longis, thoracis basim attingentibus, aeneis, ab articulo quarto (incl.) dentatis. Thorace lateribus fere subparallelis, longitudine $1\frac{1}{5}$ latiore, depressione subtili antescutellari, impressione in utroque angulo antico; sculptura striarum transversarum subtili, striarum intervallis punctis densis minutissimis longitudinalibus ornatis. Carina humerali convexa, longa, antice fere in dimidio longitudinis cum carina laterali conjuncta. Carina laterali fere recta, carina submarginali ab ea antice valde divergente, postice in angulis basalibus cum ea conjuncta. Lobo gulari antice levissime truncato-emarginato. Scutello transverse carinato. Elytris elongatis, aequalibus, carina humerali recta, usque ad tertiam partem anteriorem distincta, convexis, pone medium paulo dilatatis, dein ad apices singulatim modice attenuatis ibique minutissime denticulatis; sculptura rugarum squamiformium transversalium subtilium, quorum intervallia sicut in thorace punctis longiusculis minimis aequalibus ac haud densis repleta sunt. Superficie tota pube curta albida aequali ornata. Subtus aeneus, abdomine convexo, minutissime punctato, pube brevissima albida. Abdominis segmento ultimo apice late, haud profunde emarginato. Pedibus aeneis, tarsis longis, tarsorum posteriorum articulo primo sequentes tres longitudine attingente. Unguiculis simpliciter dentatis.

Patria; Sulu Islands (coll. *Obenberger*). Long. 4.7 mm.

This species is characterized by the fine sculpture of the upper surface and the presence of a relatively short, humeral carina.

[8] Philip. Journ. Sci. 18 (1921) 358, 397.

[9] Trans. Ent. Soc. London (1874) 327.

Golden, bronzy, moderately shining. Head convex, rather broad. Front shagreened with very feeble puncturation; anterior part of front covered with very fine, dense, golden pilosity. Antennæ long, dentate from fourth joint, reaching to base of prothorax. Prothorax long, only 1⅕ times as broad as long, with nearly parallel sides, anteriorly moderately bisinuate, with very fine sculpture consisting of fine striæ, the intervals regularly covered with very fine puncturation. Prehumeral carina convex and long, joined near middle with the lateral carina and there a little sinuate. Gular lobe very feebly emarginate, nearly truncate. Elytra relatively long, feebly dilated behind middle and then regularly narrowed to apices, which are rounded and very finely denticulated; from the humeri passes a straight, narrow, acute, relatively short, humeral carina, reaching laterally to anterior third. Sculpture fine, squamuliform, and transverse. Entire surface covered with a very regular, fine, dense, white pilosity; extreme lateral parts feebly cupreous; sculpture finer at apices. Undersurface æneous, shining, abdomen convex, very finely, sparsely sinuate, with very short, sparse, white pubescence. Legs æneous, tarsi relatively long; first joint of posterior tarsi as long as the three following together. Claws simply dentate, lower portion not turned inward.

Agrilus cannulus sp. nov. Plate 2, fig. 2; Plate 3, fig. 18.

Obscure æneus, subtus obscure viridi-aeneus, nitidior. Curtulus, dorso elytrorum paulo deplanato, convexus. Capite convexo, fronte ad verticem valde attenuata, tenui, antice pube albida ornata, rugosa. Vertice impresso, longitudinaliter striato. Antennis viridi-aeneis, thoracis dimidium haud attingentibus, ab articulo quarto (incl.) dentatis. Prothorace longitudinis 1½ latiore, antice valde bisinuato, transversali, transverse haud fortiter striato, impressione rotunda antescutellari lata, impressione obliqua subtili in utroque angulo anteriore. Carina praehumerali curta, forti, fere recta, a carina marginali valde divergente. Carina marginali recta. Carina submarginali antice valde divergente, dein ad basim ad illam lateralem convergente ac iam ante angulis basalibus juncta. Lobo gulari late rotundato, integro. Lateribus fere rectis, solum antice paulo rotundato attenuatis. Scutello transverse carinato. Elytris curtis, robustis, lateraliter fere totum abdomen tegentibus, dense subtiliter granulosis, et superficie tota pube subtilissima grisea aequali tecta carina laterali recta ac curta humerali,

fere solum quintam vel sextam elytrorum longitudinis partem attingente; pone medium haud dilatatis, dein ad apices modeste rotundato-attenuatis ac conjunctim rotundatis. Abdomine nitidiore, segmento primo subtiliter transverse striato, segmento anali apice curte sed profunde emarginato. Femoribus omnibus in parte interiori ac apicali late emarginatis, hac emarginatione tertiam partem longitudinis femoris attingente. Tarsis curtis, tarsorum posteriorum articulo primo duo sequentes longitudine adaequante. Unguiculis simpliciter dentatis.

Patria: Mindanao, Dapitan (*Baker*). Long. 4–5.7 mm.

Short, robust, cylindric, with elytra dorsally feebly depressed. Dark bronzy, feebly shining; undersurface more lustrous. Head convex; front narrow, laterally very distinctly narrowed to vertex, with feebly arcuate sides, densely rugulose; anterior preoral part clothed with very dense, fine, white pubescence. Antennæ rather long, greenish metallic, dentate from fourth joint. Vertex impressed and with longitudinal striation. Thorax short and convex, with nearly parallel sides, which only at apex are feebly rotundate and narrowed. Sculpture fine and regular. A large but not deep circular impression before scutellum, and on each side an oblique depression. Elytra short, moderately depressed dorsally, laterally nearly parallel to behind middle, then feebly narrowed to apex, and there commonly rounded. Humeral carina straight, acute but very short, reaching only to basal fifth or sixth of elytra; sculpture very fine, granulose and dense; entire surface covered with fine, recumbent, short, gray pilosity. Abdomen more shining, last ventral segment on tip shortly but deeply, rugulosely emarginate. Femora in inner apical third laterally emarginate. Tarsi short, first joint of posterior tarsi as long as the next two together. Claws simply cleft, lower portion not turned inward.

This species is very remarkable in size, form of legs, elytra, front, etc.

Agrilus exclusus sp. nov. Plate 2, fig. 1; Plate 3, fig. 17.

Aeneus, nitidus, capite viridescente elytris obscure-aeneis, nitidis. Capite convexo, fronte alutacea, lateribus subparallelis, antice paululo sinuatim convergentibus, pube aurea splendida antice lateribusque anticis ornata; antennis viridescentibus, ab articulo quarto dentatis, satis curtis. Vertice profunde late impresso. Thorace longitudinis $1\frac{1}{2}$ latiore, lateribus rectis, subconvexo, impressione antescutellari subtili, impressione obliqua

in utroque angulo anteriore. Sculptura thoracis subtili striarum transversalium; in striarum intervallis minute punctatus. Carina praehumerali longa convexa in longitudinis dimidio cum carina laterali conjuncta, carina laterali fere recta, antice leviter declivi, carina submarginali cum ea antice divergente, in angulis basalibus juncta. Elytris longioribus, pone medium paulo dilatatis, dein ad apicem modice attenuatis ac ibi rotundatis ac minutissime denticulatis. Sculptura rugarum transversalium minute punctulatarum, superficie tota pube aequali brevi aureola tecta. Carina humerali laterali recta usque ad quartam partem basalem distincta. Lobo gulari modice emarginato; ultimo abdominis segmento emarginato. Abdomine minutissime punctato ac brevissime sparse albo pubescente. Tarsis curtis, tarsorum posticorum articulo primo sequentes tres longitudine adaequante. Unguiculis simpliciter dentatis.

Patria: Mindanao, Dapitan; Basilan Island (*Baker*). Long. 3.8–4.2 mm.

Elongate, æneous, rather shining. Head convex, but not very broad, front elongate, very feebly attenuate anteriorly, nearly parallel-sided; anterior part covered with splendid golden pilosity. Antennæ greenish, rather short, dentate from fourth joint. Vertex deeply grooved and impressed on middle. Prothorax 1.5 times as wide as long, nearly straight and parallel on sides, with very fine striæ, the intervals covered with extremely fine puncturation. Gular lobe emarginate. Elytra long and rather attenuate, feebly depressed dorsally, with relatively short, straight humeral carina, reaching from humeri to first fourth. Sculpture of elytra fine, finer toward apex; behind middle elytra feebly dilated and then moderately narrowed to apices which are rounded and very feebly denticulate. Entire upper surface covered with short yellow pubescence. Abdomen convex, very finely punctured and covered with very fine, short, sparse, white hairs. Last ventral segment shallowly, widely emarginate at tip. Legs bronzy, short; first joint of posterior tarsi as long as the three following together. Claws simply cleft, lower portion not turned inward.

I have four specimens before me, three from Dapitan and one from Basilan Island. The specimen from Basilan has a more cupreous thorax, but it differs in no other particular from the other types.

This species is very well characterized by its short humeral carina, color, and form.

Agrilus perniciosellus sp. nov. Plate 2, fig. 6; Plate 3, fig. 22.

Elongatus, dorso subplanus, aeneus, capite obscuriore, thorace violaceo, lateribus aenescentibus. Capite satis convexo, fronte obscura, alutacea, sine sculptura alia, solum antice transverse subtiliter rugosa. Lateribus ad anticem paulo attenuatis. Antennis viridi-aeneis, ab articulo quarto dentatis, satis curtis. Vertice longitudinaliter impresso, alutaceo, subtilissime longitudinaliter striato. Thorace convexo, longitudine $1\frac{1}{4}$ latiore, lateribus fere rectis, basi ad anticem paulo convergentibus; sculptura parum profunda, transversali. Carina praehumerali acuta, convexa, longa, ante medium cum carina laterali conjuncta. Carina laterali leviter sinuata. Carina submarginali cum illa basi juncta, ad anticem divergente. Gulari lobo integro, rotundato. Scutello transversim carinato. Elytris elongatis, dorso subdeplanatis, minutissime sculptis, pone medium paulo dilatatis, dein ad apicem fortiter attenuatis, apicibus attenuatis ac curte rotundatis, denticulatis. Carina humerali recta curtaque, usque ad elytrorum quintam partem anteriorem vel usque ante apicem coxarum posteriorum distincta. Superficie tota pube densissima, curta, minuta, subtilissima albosericea tecta. Pedibus viridi-aeneis. Tarsorum posticorum articulo primo tres sequentes longitudine adaequante. Unguiculis simpliciter dentatis. Abdomine aeneo, convexo, segmento anali apice truncato.

Patria: Malay Peninsula, Wellesley (coll. *Obenberger*). Long. 4.5 mm.

Rather elongate, with fine sculpture; head obscurate, æneous, front moderately narrowed to apex, shagreened, without other sculpture; only preoral part transversely rugose. Vertex impressed, very finely longitudinally striate. Prothorax rather convex, with splendid violaceous color, only on sides more æneous; greatest width at base, then feebly narrowed to apex. Sculpture of prothorax very fine, transverse. Prehumeral carina long and convex, reaching to before middle of lateral carina and there joined to it; lateral carina feebly sinuate, nearly straight. Scutellum carinate. Gular lobe rounded, not emarginate. Elytra rather long, a little dilated behind middle, then strongly narrowed to apex which is narrowly rounded and finely denticulate. On back elytra are depressed, plane; sculpture very fine; entire surface covered with dense, very short, equal, very fine, silky, white pubescence. A straight, short humeral carina reaches basal fifth (or before the hind apical margin of hind coxæ). Last ventral segment truncate on apex. Legs

greenish, first joint of posterior tarsi as long as the following three together. Claws simply cleft, lower portion not turned inward.

This species belongs to the group of *A. perniciosus* H. Deyrolle, characterized by the small, equal size and the presence of a straight humeral carina on the elytra. In this group this species can be easily distinguished by its color, modification and shortness of humeral carina, very dense and equal pilosity above, etc.

Agrilus lazar sp. nov. Plate 3, fig. 6; Plate 4, fig. 12.

Parvus, elongatulus, subconvexus, obscure æneus; capite convexo, lato, margine thoracis anteriore paulo latiore, fronte lata, alutacea, ad anticem leviter attenuata, nigra, impunctata, vertice leviter impresso, minutissime sculpto. Antennis aeneis, ab articulo quarto dentatis. Thorace lato, subconvexo, in dimidio latitudinem maximam attingente, lateribus rotundatis, margine antico bisinuato; disco obscurato, lateribus basique laetius viridi-aeneo, impressione profunda transversali lata ante basim atque depressione obliqua in utroque angulo antico. Sculptura minuta rugarum transversalium. Carina humerali parum convexa, antice cum illa laterali juncta, carina laterali recta, carina submarginali antice paulo divergente. Lobo gulari rotundato, integro. Elytris subtiliter sculptis, pube uniformi, aurea, curta, aequali; lateribus antice fere rectis, pone medium paululo dilatatis, dein ad apicem attenuatis, apicibus rotundatis ac minutissime denticulatis. Carina laterali recta, acuta humerali, usque ad $\frac{3}{5}$ longitudinis elytrorum distincta. Segmento anali ultimo apice integro, rotundato. Tarsis obscuris, curtis, unguiculis simpliciter dentatis.

Patria: Singapore (*Baker*). Long. 3.2 mm.

Small, elongate, convex, dark æneous, with moderate luster. Head black, median part of prothorax obscurate. Head convex, a little broader than anterior edge of prothorax, without distinct sculpture on front. Front shagreened, feebly narrowed anteriorly. Vertex feebly impressed, without distinct sculpture. Antennæ serrate from fourth joint. Prothorax rounded on sides, the greatest width in the middle, convex, with rather deep and broad transverse impression before base, and with an oblique depression in each anterior angle. Prehumeral carina very feebly convex, but entire and anteriorly joined to lateral carina. Scutellum transversely carinate. Gular lobe entire and rounded. Elytra dark, æneous, very feebly dilated

behind middle, and then narrowed moderately to apices, which are separately rounded, and very feebly denticulate at tip. Entire surface covered with fine, short, equal, uniform golden pubescence. The humeral carina is very well developed and reaches to 0.4 of length. Undersurface moderately convex, rather shining, last ventral segment rounded at tip. Tarsi short; claws simply cleft, lower portion not turned inward.

This species belongs in the group of *A. perniciosus* Deyrolle. A single specimen of this species is in the Baker collection.

Agrilus optatus sp. nov. Plate 2, fig. 36; Plate 4, fig. 26.

Affinitatis *Agrili iliganensis* Fisher.

Elongatus, convexus, capite nigro (♂) vel viridi-coeruleo (♀), thorace nigro, lateribus viridescentibus, elytris obscure aeneis, fere nigris, subtus obscure-aeneus, nitidus. Capite lato, margine thoracis anteriore latitudine non superante fronte subconvexa, lateribus leviter rotundatis, subcanaliculatis; rugis satis fortibus transversis. Vertice impresso, obscuro, longitudinaliter minute striato. Antennis obscure aeneis, ab articulo quarto dentatis. Prothorace longitudine $1\frac{1}{2}$ latiore, latitudinem maximam in tertia parte anteriori attingente, dein ad basim leviter subsinuate attenuato; impressionibus levibus: una praescutellari circulari, una utrinque in angulo thoracis anteriore. Sculptura subtili striarum transversalium; intervallis striarum alutaceis. Carina humerali longa, convexa, antice leviter sinuata ac cum carina laterali in tertia parte anteriori conjuncta. Carina laterali fere recta, carina submarginali antice cum illa divergente, baseos conjuncta. Gulari lobo levissime sinuato-emarginato. Scutello transverse carinato. Elytris longis, nigris, dorso modice deplanatis, carina humerali usque ad tertiam superficie tota pube brevi aequali aurea ornatis; solum lateribus pone medium modice dilatatis, dein ad apicem modice attenuatis ac separatim rotundatis, apicibus subtilissime denticulatis. Sculptura elytrorum subtili, squamiformi transversa; superficie tota pube brevi aequali aurea ornatis; solum lateribus extremissimis obscuratis ac pube curta obscura indistincta tectis. Abdominis segmento ultimo apice truncato; tarsis curtis, unguiculis simpliciter dentatis.

Patria: Mindanao, Dapitan (*Baker*). Long. 4.2–5 mm.

Dark æneous; head black (male) or greenish blue (female); prothorax black, laterally with slight greenish luster, elytra dark æneous, nearly black, moderately shining. Head rather

large, front rather strongly transversely striate; vertex impressed on middle, longitudinally striate. Antennæ serrate from fourth joint, dark æneous. Prothorax convex, 1.5 times broader than long, the greatest width in anterior third part, then very feebly sinuate, and narrowed to base; with a small circular depression before scutellum, and on each side with an oblique impression in the anterior angles. Gular lobe very feebly sinuate-emarginate. Scutellum transversely carinate. Elytra long, laterally very feebly sinuate, nearly parallel, the greatest width behind the middle; lateral parts of first abdominal segment above not entirely covered. Apex of elytra rotundate and very feebly denticulate. A very distinct, sharp, straight humeral carina on sides which is distinct to behind anterior third. Sculpture of elytra fine, squamiform and transverse; entire surface covered with fine, short, equal golden pilosity; only the sides are more obscurely colored and with a short, not very conspicuous pubescence. Last ventral segment truncate. Claws simply cleft, lower portion not turned inward.

Similar to the other species with carinate elytra, but of narrower and more-parallel form.

Agrilus oneratus sp. nov. Plate 2, fig. 7; Plate 3, fig. 23.

Curtus, elongatulus, elytrorum dorso paulo deplanato; capite viridi-aeneo, thorace aeneo, medio cuprescente, elytris obscure aeneis, fere nigris, carinatis. Capite lato, latitudinem marginis thoracis anterioris haud superante, fronte subconvexa, alutacea, antice aureo pilosa, vertice impresso, transverse rugosulo. Thorace convexo, longitudine $1\frac{1}{5}$ latiori, latitudinem maximam in medio attingente, lateribus subtilissime rotundatis, lateribus posticis rectis; depressione rotunda praebasali, angulis anticis oblique impressis. Sculptura transversa subtili. Carina praehumerali forti, subconvexa, cum carina laterali in medio longitudinis lateralis conjuncta; carina laterali leviter subsinuata, carina submarginali ea antice patis approximata ac subparallela, baseos conjuncta. Lobus gularis rotundatus, non emarginatus. Scutello carinato. Elytris dorso subplanis, subrobustis, obscuribus, sculptura minuta; lateraliter usque pone medium fere parallelis, dein paullo dilatatis ac ad apicem attenuatis; apicibus rotundatis, minutissime denticulatis; lateribus pilosis superioribus segmentis abdominis primi detectis. Carina acuta recta humerali, usque ad $\frac{2}{5}$ longitudinis distincta. Superficie elytrorum pube obscura tecta, solum secundum suturam pilositate

longiore albida haud regulari atque in tertia parte postica interrupta. Segmento anali integro. Tarsis curtis, articulo tarsorum posteriorum primo tres sequentes longitudine adaequante. Unguiculis simpliciter dentatis. Antennis obscure aeneis ab articulo quarto (incl.) dentatis.

Patria: Malay Peninsula, Wellesley (coll. *Obenberger*). Long. 3.5 mm.

Short, narrow, elytra subdepressed dorsally. Head brassy green, shagreened, anteriorly with fine golden pubescence. Vertex impressed, with transverse sculpture. Head convex, but not larger than anterior margin of prothorax. Antennæ brassy green, dentate from fourth joint. Prothorax convex, with small circular depression before base, with oblique impression in the anterior angles, 1.2 times as broad as long, the greatest width in the middle, feebly rotundate on sides, with rectangular hind angles. Sculpture superficial and fine. Prehumeral carina anteriorly joining lateral carina nearly in the middle. Gular lobe entire, rotundate. Scutellum transversely carinate. Elytra relatively short, the greatest width behind the middle and here feebly broadened, then narrowed to apex, which is separately rounded and finely denticulate; from humeri pass very sharp, straight humeral carinæ, which are distinct to anterior two-fifths. Sculpture of elytra fine, surface covered with obscure pubescence; only a large space along suture clothed with white, sparse pilosity, which is largely interrupted in apical third part. Abdomen dark bronzy, shining, with very fine sculpture and with extremely short, sparse, fine, white pilosity. Last ventral segment truncate. Tarsi short; first joint of hind tarsi as long as the three following together. Claws simply cleft, lower portion not turned inward.

Agrilus perniciosus H. Deyrolle. Plate 3, fig. 10; Plate 4, fig. 3.

One specimen of this species comes from Sandakan, Borneo (*Baker*). The species is very similar to my *Agrilus pterochlorus,* but differs very much in the form of the head, which is larger and more convex, with shorter antennæ; shorter and laterally more-rounded prothorax, with longer humeral carina which apically is nearer lateral margin of elytra; also in the darker color of the upper surface, etc.

Genus APHANISTICUS Latreille

A widely distributed genus; a large number of species is known from Africa and from the Oriental and Palæarctic Re-

gions. Only three, rather problematic species, which should perhaps be placed in the genus *Germarica* Blackburn, are described from Australia.

By a queer error some species of *Cylindromorphus* were described by Kerremans as species of *Aphanisticus;* for example, *Aphanisticus bodongi* Kerremans, mentioned from the Philippines, of which I have a paratype in my collection, is a true *Cylindromorphus.*

Some species of this genus are known as dangerous destroyers of sugar plants in Sumatra and eastern India.

Key to species of Aphanisticus Latreille.[10]

a^1. Surface brilliant green; 3.2 millimeters. (Central Borneo.) **A. bohaci sp. nov.**

a^2. Surface black, sometimes with olivaceous, æneous, or cupreous reflections.

b^1. Elytra with longitudinal costæ.

c^1. Prothorax broadly cordate. Elytral intervals without more distinct transverse costulæ between the longitudinal costæ. Scutellum visible.

d^1. Larger, olivaceous. Greatest width of prothorax in front of the middle; 5 millimeters. (Borneo.).... **A. corniceps sp. nov.**

d^2. Smaller, black. Greatest width of prothorax in the middle; 4 millimeters. (Luzon.)........ **A. costipennis Fisher.**

c^2. Prothorax transverse, sides evenly arcuate, elytral intervals on anterior part of disk transversely costate; scutellum invisible. Black.

d^1. Wider, median costa of elytra rather indistinct posteriorly. Head without longitudinal impression behind on vertex, in front of anterior margin of prothorax; 3.5 millimeters. (Malay Peninsula.)........ **A. perakensis sp. nov.**

d^2. Narrower, the elytral costæ strongly elevated. Median costa posteriorly very distinctly elevated. Head with a short longitudinal impression behind on vertex, in front of anterior margin of prothorax; 3.25 millimeters. (Mindanao.) **A. bakeri Fisher.**

b^2. Elytra without distinct longitudinal costæ.

c^1. Head deeply excavated between eyes.

d^1. Pronotum distinctly transversely grooved at middle. Elongate, rather convex, head and prothorax dark bronzy, elytra black, shining; 3.5 millimeters. (Luzon.)........ **A. excavatus Fisher.**

d^2. Pronotum without distinct transverse impression at middle.

e^1. Elytra without distinct rows of punctures. Elongate, uniformly piceous, with a bronzy reflection on head and prothorax; 2.9 millimeters. (Luzon, Mindanao.) **A. piceipennis Fisher.**

[10] *Aphanisticus nigroaeneus* Kerremans is not represented in this key. *Aphanisticus bodongi* Kerremans is in reality a *Cylindromorphus.*

e^2. Elytra distinctly rather densely seriate-punctate. Rather depressed, dark grayish æneous, with æneous or greenish lateral margin of prothorax. Front æneous; 3 millimeters. (Borneo.) .... **A. sandakanus** sp. nov.

c^2. Head not at all or feebly excavated between eyes.

d^1. Form very elongate. Dark cupreo-æneous. Prothorax 1.2 times as wide as long; 3.75 to 4 millimeters. (Penang, Singapore.) .... **A. peninsulae** sp. nov.

d^2. Form shorter, prothorax wider and shorter.

e^1. Pronotum with a deep fovea near posterior angles.

f^1. Head rounded in front. Uniformly shining black, with a slight bronzy reflection on sides of pronotum; 3 millimeters. (Mindanao.) .... **A. mindanaoensis** Fisher.

f^2. Head narrowly, deeply emarginate in front. Dark bronzy, lateral margins of prothorax greenish bronzy, shining; 2.75 millimeters. (Palawan.) .... **A. foveicollis** Fisher.

e^2. Pronotum without deep fovea near posterior angles.

f^1. Form slender; prothorax widest in front of middle. Uniformly shining black; 3 millimeters. (Luzon.) **A. unicolor** Fisher.

f^2. Form robust; prothorax widest at middle.

g^1. Uniformly bright bronzy black. Front slightly, broadly excavated between eyes. Sides of prothorax widest behind middle, then more strongly narrowed anteriorly; 3.25 millimeters. (Leyte, Mindanao.) **A. trachyformis** Fisher.

g^2. Black, front flat, without excavation between eyes. Sides of prothorax subparallel on basal half, moderately rounded anteriorly; 3.5 millimeters. (Mindanao.) **A. dapitani** sp. nov.

Aphanisticus bodongi Kerremans.

This species, of which I have in my collection a paratype, is in reality a *Cylindromorphus*. Kerremans has committed more such errors in describing distinct species of *Cylindromorphus* from the African fauna as belonging to *Aphanisticus*, as I have recently found from the types, in connection with his paper.[11] The species there described, *Aphanisticus jeanneli* and *A. alluaudi* Kerremans, the types of which were sent me from the Paris Museum for study, are distinctly *Cylindromorphus* species. The genus *Cylindromorphus* seems to be rather rare in the Oriental Region, though perhaps some species will still be found intermixed with *Aphanisticus*. They are very easily separable from *Aphanisticus* by the position of the eyes. In *Aphanisticus* the eyes (seen laterally) always have the hind margin sinuate or emarginate, while in *Cylindromorphus* the hind margin of

[11] Buprestidæ (par Ch. Kerremans). Voyage de Ch. Alluaud et R. Jeannel en Afrique orientale, Coleopteres 6 (1917) cahier 28, pg. 236.

the eyes is perpendicular and straight, or nearly so. Also, the elongate thoracic carina often present in *Cylindromorphus* is a character which does not occur in true *Aphanisticus*.

Aphanisticus bohaci sp. nov. Plate 1, fig. 7.

Corpore supra satis deplanato, alutaceo, laete viridi olivaceo, subtus nigro. Capite medio valde concavo, longo, oculorum marginibus interioribus acutis. Fronte aurata, nitida, fere parallela, satis longa. Thorace longitudine bis latiore, ante medium latitudinem maximam attingente, ad anticem valde rotundatim attenuato, ad basim sinuatim angustato, marginibus satis late deplanatis, impressionibus tribus (media, praebasali ac post marginem anteriorem) transversis fortibus ornato. Scutello minutissime, triangulari. Elytris latitudinis fere 2¼ longioribus, latis, deplanatis, ante apicem prope suturam late haud profunde canaliculatis, alutaceis, usque ad medium fere parallelis, post humeris lateraliter leviter impressis, dein ad apicem attenuatis ac apicibus separatim transverse obtusis. Sutura postice elevata; elytrorum disco postice late obscurato. Corpore subtus nigro, antennis auratis, pedibus nigris, prothorace subparallelo.

Patria: Central Borneo (coll. *Obenberger; Boháč* leg.) Long. 3.2 mm.

Body rather depressed; very distinctly shagreened; of a beautiful, silky, olivaceous green color. Head rather large, with a wide frontal excavation; inner margins of eyes acute. Front shining, golden, nearly parallel, rather long, and rather narrow. Prothorax nearly twice as wide as long, the greatest width before the middle, then rather strongly sinuate to base, and strongly rounded to anterior angles. Sides rather flattened; disk adorned by three deep transversal impressions. Elytra rather wide, rather flattened, with some feebly indicated longitudinal elevations behind base, widely channeled along suture before apex, apices separately obtuse. Surface of elytra very distinctly shagreened, with a silky, somewhat darker, large macula in posterior part. Antennæ golden, undersurface and legs black.

The single type is in my collection. It was collected by Professor Boháč, an officer of the Czechoslowak Legionaries (Siberian Volunteers) who, returning in 1919 from Vladivostok to Bohemia, was left behind with other specialists that they might make a scientific excursion to inner Borneo. A few insects were collected, among which are *Aphanisticus bohaci, Trachys*

praora, and *T. miana,* described in this paper. Their collection of plants is of great scientific value.

Aphanisticus corniceps sp. nov. Plate 1, fig. 1.

Elongatus, supra deplanus, obscure olivaceo griseus, alutaceus, paullo sericeo nitidus; capite magno, oculorum marginibus intus acutis, fronte inter oculos valde rotundatim excavata, nitida. Prothorace lato, longitudine circiter 1½ latiore, lateribus deplanatis, latitudinem maximam in parte tertia anteriori attingente; lateribus antice rotundatis, postice ad basim fere recta, satis fortiter attenuatis. Disco in medio late transverse canaliculato, antice ac ante basim transverse depresso. Scutello parvo, triangulari. Elytris latis, latitudine fere 2½ longioribus, pone medium leviter dilatatis, apicibus late separatim rotundatis; superficie alutacea, satis plana; humeris leviter prominulis, in elytrorum disco carina una longitudinali mediana, carina curta inter eam longam atque suturam posita, carinaque simili brevi in parte elytrali posteriori intra eam longam atque marginem sita ornatis; unaque etiam carina male indicata in parte elytrali apicali marginem lateralem marginante. Carinis illis omnibus satis male indicatis, satis indistincte elevatis. Prosterno antice leviter impresso. Abdomine nigro, glabro. Pedibus nigris, tarsorum articulis subtus luteis ac fortiter dilatatis.

Patria: Borneo, Sandakan (*Baker*). Long. 5 mm.

Elongate, depressed, dark olivaceous gray, feebly silky shining. Head large, laterally parallel, in the middle strongly and deeply emarginate, with acute inner margin of eyes. Prothorax wide, nearly 1.5 times wider than long, the greatest width in anterior third laterally, anteriorly strongly rounded, posteriorly attenuate in a straight line to base. Disk in the middle widely and rather strongly impressed; anterior and posterior margins of prothorax transversely depressed. Elytra rather long, subparallel, a little widened behind middle, then attenuate to apex which is widely and separately rounded. Surface covered with very distinct shagreening, and presenting on each side a median longitudinal, better-developed carina, with two other short carinæ; one between suture and median carina on basal part of each elytron, the other between median carina and lateral margin on apical part. There is also a curved sublateral carina, parallel and near to lateral margin. All these carinæ are rather feebly developed and not very high. Abdomen hairless and blackish. Prosternum with a small punctiform impression ante-

riorly. Legs blackish, tarsi short, undersurface of each tarsal article yellow and broad; tarsi much wider than usual.

Aphanisticus sandakanus sp. nov. Plate 1, fig. 6.

Niger, nitidus, fronte aeneo; corpore satis depresso; capite magno, convexo, subparallelo, oculis parvis, haud prominulis, fronte valde concava, latitudinis paullo longiore. Thorace longitudine fere $1\frac{3}{4}$ latiore, satis deplanato, in medio latitudinem maximam attingente, ad basim leviter sinuatim, ad anticem valde ac rotundatim attenuato; antice ac ante basim fortiter transverse impresso, lateribus satis late deplanatis; scutello minutissimo, triangulari. Elytris usque ante medium parallelis, lateribus pone humeris impressis, ad apicem fortiter, longe attenuatis, apicibus tenuiter separatim rotundatis, cupreo unicaulibus. Superficie minute ac subtiliter seriatim punctata, seriebus his in parte apicali evanescentibus; elytris haud robustis, latitudine fere $2\frac{1}{3}$ longioribus. Prosterno parallelo. Corpore subtus pedibusque nigris, antennis auratis.

Patria: Borneo, Sandakan (*Baker*). Long. 3 mm.

Black, rather shining, only the front brassy. Body rather depressed. Head rather large and convex, with small and not prominent eyes. Front excavated, parallel-sided, a little longer than wide. Preoral pores visible from before. Antennæ golden. Prothorax rather wide, nearly 1.75 times wider than long, rather uneven, having two strong transverse impressions, one before base and the other behind anterior margin which is strongly emarginate; lateral margins rather flattened on sides, the greatest width in the middle, then attenuate and a little sinuate to base, and rounded at anterior angles. Prosternum rather narrow and parallel. Scutellum very small and triangular. Elytra rather flattened, nearly $2\frac{1}{3}$ times longer than wide, with a lateral impression behind humeri, parallel to the middle, then attenuate to apex, where they are narrowly and separately rounded and narrowly cupreous; sculpture consisting of fine, dense, punctate striæ which disappear before apex. Underside and legs black.

The single type of the Baker collection bears the No. 12633.

Aphanisticus peninsulae sp. nov. Plate 1, fig. 3.

Elongatus, obscure cupreo-aeneus, supra modice depressus, attenuatus. Capite satis convexo, in medio levissime depresso, fronte tenui, lateribus parallelis. Thorace satis elongato, longitudine solum $\frac{1}{5}$ latiori, in parte anteriori quinta latitudinem maxi-

mam attingente, lateribus haud deplanatis, ad basim ac ad anticem solum modice attenuatis, in medio ac ante basim depressione transversa lata ac haud profunda. Scutello minuto, triangulari. Elytris latitudine fere 3¼ longioribus, post medium paulo dilatatis convexis, glabris, alutaceis, antice subtiliter dense, haud distincte seriatim punctatis, sculptura hac in parte apicali evanescente; lateribus ad apicem satis fortiter ac longe attenuatis, apicibus singulatim rotundatis. Prosterno haud lato, parallelo.

Patria: Penang Island; Singapore (*Baker*). Long. 3.75–4 mm.

Elongate, hairless, dark cupreo-æneous, with a fine, microscopical sculpture (shagreening) ; rather convex; head rather large and rather convex, with a very feeble median impression; front between eyes narrow and with parallel sides. Preoral pores visible from before. Thorax rather long, only 1.2 times as wide as long, the greatest width in anterior fifth part, then rather feebly attenuate to base; on disk with a median and a basal transverse depression. Scutellum very small and triangular. Elytra elongate, rather narrow, a little enlarged behind middle, then rather strongly attenuate to apex, where they are separately rather narrowly rounded at tip. Sculpture consists of a rather fine series of rather indistinctly indicated punctures, which disappear on apical half of elytra.

This species resembles very much some forms from eastern India and Sumatra. There are two types in the Baker collection.

Aphanisticus bakeri Fisher. Plate 1, fig. 4.

In the material sent to me there was a single specimen of this very interesting species, taken at Iligan, Mindanao (*Baker*), from which has been prepared the figure given here.

Aphanisticus perakensis sp. nov. Plate 1, fig. 2.

Niger, minutissime alutaceus, satis nitidus elongatus, paulo convexus. Capite satis magno, latitudine longitudinem ¼ superante, lateribus subparallelis, oculis parvis, temporibus longis, inter oculos profunde rotundatim late excavato, oculis intus acute marginatis. Thorace longitudini fere bis latiori, latitudine maxima in medio; hic subanguloso, lateribus ad apicem ac ad basim fere recte attenuatis. Superficie in angulis anticis ac posticis impressa, in medio linea transversali forti impressa; ante marginem basalem ac anteriorem transverse depressa. Prosterno subparallelo, satis lato. Elytris latitudinis fere 2⅓

longioribus, humeris leviter prominentibus, in medio lateraliter paullo dilatatis, dein ad apicem subrotundato attenuatis ac apicibus separatim satis tenuiter truncato rotundatis. Lateribus post humeris leviter impressis, superficie propter impressionem latam praesuturalem ac apicalem ac propter carinam longitudinalem brevem ac haud fortiter elevatam satis in aequali. Inter hanc carinam basalem ac inter suturam rugae nonnullae transversae haud densae observantur. Sutura postice satis fortiter elevata. Abdomine glabro, nigro, segmento anali apice truncato. Pedibus nigris, tarsis subtus testaceis.

Patria: Malay Peninsula (coll. *Obenberger*). Long. 3.5 mm.

Black, rather shining, covered with fine microscopical shagreening. Form elongate, but rather depressed. Head rather large, nearly parallel laterally, in the middle between eyes with a deep, wide, rounded emargination. Prothorax nearly twice as broad as long, the greatest width in the middle, then subangulate and attenuate in a nearly straight line to base and to apex, with a small depression in anterior and hind angles, with a deep and rather narrow median, transverse, entire impression; behind anterior margin and before base with a transverse depression. Scutellum triangular and small. Elytra rather elongate, about $2\frac{1}{3}$ times longer than wide, the greatest width before the middle, where they are a little enlarged, then attenuate to apex which is rather narrowly separately truncately rounded; surface rather uneven, having a short basal (only before the middle) median carina; between this carina and suture, which is elevated in apical part, are some wide, not dense, transverse rugæ. Part of each elytron along suture and before apex widely concave. Undersurface and legs black, only the tarsi testaceous. Prosternum without impression, rather wide, parallel, rounded at tip.

The single specimen of this small species in my collection came from the old collection of Meyer-Darcis.

Aphanisticus dapitani sp. nov. Plate 1, fig. 5.

Niger, nitidus, minutissime sculptus, glaber; corpore satis deplanato. Capite satis parvo, fronte haud impressa, inter oculos parallela, attenuata. Oculis haud prominentibus. Thorace glabrato, aequali, longitudine fere bis latiore, antice fortiter rotundatim emarginato, angulis anticis satis prominulis, postice valde sinuato, lobo medio producto; lateribus deplanatis, disco aequali, nitido, haud canaliculato. Latitudinem maximam in medio attingente, ad basim parallelo, ad anticem satis fortiter rotundatim attenuato. Scutello triangulari, parvo. Elytris

latis, sutura postice parum elevata; humeris leviter prominentibus, lateribus post humeris impressis. Elytris ante medium leviter dilatatis, dein ad apicem longe ac satis fortiter attenuatis, apicibus leviter obliquis ac tenuiter separatim obtusis. Superficie minutissime sculpta, alutacea, in parte anteriori elytrorum punctis aliquot minutissimis haud valde distinctis. Prosterno ad apicem valde dilatato, lato.

Patria: Mindanao, Dapitan (*Baker*). Long. 3.5 mm.

Rather wide; upper surface rather depressed; black, rather shining, with a very fine sculpture. Head rather small, convex, front between eyes parallel; preoral pores covered and not visible from in front. Prothorax rather wide, equal, without transverse impression, with rather widely deplanate sides, and with a deep and semicircular emargination on anterior margin; basal margin very sinuate, median lobe produced. Elytra rather depressed, nearly 2.5 times as long as total width, with rather prominent humeri, having small lateral impressions behind them; before middle a little enlarged, and then rather strongly attenuate to apex, which is a little oblique and obtuse at tip. Prosternum rather wide and enlarged at tip.

A single type in the Baker collection bears the number 13791.

Genus **ENDELUS** H. Deyrolle

This genus resembles *Aphanisticus* in many cases, and probably has the same manner of life. No species of the genus known to me has the microscopical shagreening always present in *Aphanisticus*.

Key to the species of Endelus H. Deyrolle.

a^1. Surface of elytra very uneven; wide, elongate species. Head very wide, but narrower than the cordiform pronotum. Dark violaceous, shining; 4.5 millimeters. (Luzon.) ..... **E. belial sp. nov.**

a^2. Surface of elytra evenly convex, without impressions.

b^1. Form robust, head much narrower than pronotum. Broadly ovate, head and pronotum bluish black, the latter with the anterior angles reddish, shining, elytra bright violaceous; beneath bronzy green; 5.25 millimeters. (Mindanao.) ..... **E. violaceipennis Fisher.**

b^2. Form elongate, head as wide or nearly as wide as pronotum.

c^1. Pronotum broadly cordate.

d^1. Black, with violaceous reflections. Elongate, attenuate posteriorly; black beneath. Pronotum twice as wide as long, broadly cordate, widest at anterior fourth. Elytra rather indistinctly punctured; 3.75 millimeters. (Palawan.)
E. palawanensis Fisher.

d^2. Uniformly bronzy. Shorter, pentagonal. Elytra with distinct puncturation; 3.5 to 4 millimeters. (Luzon.)

E. bakeri Kerremans.

c^2. Pronotum transverse, sides arcuately rounded.

d^1. Elytra bicolored. Elongate. Head and pronotum bright greenish bronze, elytra violaceous with a round spot on humeri, a smaller one along side of scutellum, and a transverse crescent-shaped spot behind middle, green; 3.25 millimeters. (Negros.)

E. lunatus Fisher.

d^2. Elytra unicolored, only rarely with a small humeral, rather inconspicuous spot.................................... E. aphanisticinus sp. nov.

e^1. More robust, shorter, pronotum twice or more than twice as wide as long.

f^1. Pronotum twice as wide as long, rather robust; head and pronotum bright greenish bronzy, elytra æneous; beneath bronzy; 4.5 millimeters. (Luzon.) **E. aeneipennis Fisher.**

f^2. Pronotum more than twice as wide as long. Prothorax golden or æneous, elytra blue or greenish blue.

g^1. Anterior part of front green. Front narrower. Temples not developed. Thoracic transverse impressions more approximate. Sides of prothorax more rounded. Elytra wider; 2.6 millimeters. (Borneo.)

E. borneensis sp. nov.

g^2. Front entirely golden, wider. Temples short but distinctly developed. Transverse thoracic impressions more distant. Sides of prothorax feebly rounded. Elytra slender; 2.7 millimeters. (Singapore.)

E. bakerianus sp. nov.

e^2. Elongate, agriliform. Pronotum less than twice as wide as long, narrower.

f^1. Very elongate, black with olivaceous reflection, the humeri with a minute blue spot; 4 millimeters. (Singapore.)

E. aphanisticinus sp. nov.

f^2. Without colored spot on humeri.

g^1. Elongate, very slender, agriliform; head and pronotum coppery bronze; elytra dark reddish bronze with a slight violaceous reflection; beneath bronzy; 4.75 millimeters. (Mindanao.).. E. agriliformis Fisher.

g^2. More robust; head and prothorax red, with golden reflections; elytra blue, prosternum black, remainder of undersurface æneous, with greenish reflections; 5 millimeters. (Sumatra, Java, Borneo, Singapore.)

E. empyreus H. Deyrolle.

Endelus belial sp. nov. Plate 1, fig. 11.

E. difformi H. Deyrolle simillimus.

Niger, brunnescens, nitidus, glabratus, superficie elytrorum valde inaequali. Capite latissimo, oculis valde prominulis, temporibus distinctis; fronte inter oculos valde excavata, curta,

longitudine fere latiori, cuprea; antennis nigris, curtis. Thorace in tertia parte anteriori latissimo, fortiter cordiformi ac attenuato, latitudine maxima in parte tertia anteriori; in disco impressione media profunda transversa, ac impressionibus anteriori ac basali, similibus, minus profundis. Scutello triangulari, magno. Elytris latis, lateribus usque ad medium parallelis, dein leviter dilatatis, ac ad apicem satis fortiter attenuatis, apicibus subrotundatis, latis. Superficie elytrorum nitida, his valde inaequalibus, impressionibus satis profundis ac satis latis, subrotundatis ut sequibus: una basali prope humeros, una longa, subhumerali, attenuata, una rotunda in parte tertia anteriori prope suturam, una ante medium, in elytrorum medio, una prolongata praeapicali. Corpore subtus nigro, nitido, tarsis subtus testaceis.

Patria: Philippines, Los Baños (*Baker*). Long. 4.5 mm. Lat. 1.8 mm.

This species resembles very much *Endelus difformis* H. Deyrolle.[12]

Upper surface very uneven; dark brown, nearly black, with metallic luster, shining. Head very wide; eyes laterally strongly prominent; temples distinctly developed; front widely excavated between eyes, very short, very slightly wider than long, of a coppery color. Antennæ short and black. Prothorax short, very wide, the greatest width in anterior third part, then strongly cordiform, with three transverse impressions; median impression deep and strong, the others feebler and less distinct. Scutellum relatively large and triangular. Elytra wide and rather slightly convex; sides parallel to middle, then widened and rather strongly attenuated to apex which is broad and separately rounded; surface very uneven, with two large rounded irregular impressions on disk, one basal and one preapical (elongate) depression; behind humeri with a longitudinal lateral impression. These impressions seem to be less strong than in *E. difformis*. Undersurface black, shining; prosternum broad and short; tarsi on undersurface yellowish.

From *E. difformis* this species differs by the less-developed impressions, lesser width, very different form of prothorax, etc.

Endelus bakerianus sp. nov. Plate 1, fig. 13.

Supra nitidus, glaber, subdepressus. Capite lato, glabro, in medio valde longitudinaliter impresso, impunctato, aureo, nitido. Oculis lateraliter valde prominentibus, temporibus distinctis.

[12] Ann. Soc. Ent. Belg. 8 (1864) pl. 3, fig. 9.

Epistomate valde attenuato, cavitatibus antennarum obliquis, antennis nigris ac curtis. Thorace curto, latitudine fere 2½ longiore, lateraliter latitudine maxime perparum ante medium attingente, lateribus leviter subrotundatis. Disco nitido, glabro, aeneolo, impunctato, depressionibus duo profundis transversalibus ornato. Elytris cyaneis, nitidis, glabratis, minute ac haud dense punctatis, thorace multo latioribus, lateribus usque ad medium subparallelis, dein ad apicem fortius attenuatis ac apicibus subtruncatis; humeris haud prominulis, solum impressione basali subrotundata prope humeros ac utrinque impressione longula posthumerali ornatis. Subtus corpore nigro, nitido, prosterno lato, parallelo, pedibus nigris, tarsorum articulis subtus testaceis.

Patria: Singapore (*Baker*). Long. 2.7 mm. Lat. 7.2 mm.

This species resembles very much *Endelus weyersi* Kerremans from Sumatra, but can be very easily distinguished by the smaller size, developed temples behind the eyes, tarsi, prothoracic form, and the presence of two very deep and very distinct transverse impressions on the prothorax.

Glabrous, shining, rather depressed. Head large, glabrous, without puncturation, strongly shining, of clear golden color. Eyes strongly prominent laterally, with distinct temples behind them. Prothorax brassy, broad, nearly 2.5 times broader than long, the greatest width shortly before the middle, on sides moderately rounded, without pilosity or distinct puncturation, on disk with two deep, narrow, entire, transversal impressions. Elytra feebly convex, blue, strongly shining, much broader than prothorax, laterally parallel nearly to middle, then moderately attenuate and subtruncate at apex, with two distinct impressions; one on each side in the middle of the base of elytron, the other lateral and long, behind the humeri. Undersurface dark, black, shining; legs rather short, the tarsal lamellæ red on undersurface.

Endelus borneensis sp. nov. Plate 1, fig. 14.

Speciei *E. bakerianus* sp. nov. simillimus, ac solum ita distinctus: Fronte minus lata, antice smaragdinea; temporibus post oculis nullis; thorace nitidiore, magis aurato, impressionibus transversalibus plus approximatis; lateribus thoracis magis rotundatis. Elytris cyaneis, fortius punctatis, minus latis, post humeris latitudinem maximam attingentibus, dein ad apicem in linea curvata longa rotundate attenuatis. Subtus similiter instructus, tarsis obscuris.

Patria: Borneo, Sandakan (*Baker*). Long. 2.6 mm. Lat. 1.2 mm.

This species is closely allied to *Endelus bakerianus* sp. nov. Elytra of similar color; anterior parts of front green, vertex and prothorax golden and strongly shining. Temples not developed; front narrower than in *E. bakerianus.* The two deep and straight transverse impressions more approximate. Sides of prothorax more rotundate laterally. Elytra more strongly punctured, wider, more convex, the greatest width behind humeri, and then attenuate in a slightly rounded line to apex. Undersurface black and shining; tarsi dark, nearly black.

Endelus aphanisticinus sp. nov. Plate 1, fig. 12.

Glabratus, elongatus, niger, humeris macula minima violascente ornatis, subnitidus. Corpore longo, subcylindraceo; capite lato, oculis lateraliter valde prominentibus, fronte lateribus parallelis latitudine (ab epistomate usque ad verticem) fere $1\frac{1}{4}$ longiori, punctis setiformibus post epistomalibus duo mediis valde approximatis, in medio impressione lata ac profunda longitudinali, antennis nigris. Thorace longitudine fere $1\frac{1}{3}$ latiori, lateribus rotundatis, impressionibus in disco duo transversis latis ac haud profundis. Elytris longissimis, convexis, fere impunctatis, impressione laterali post humeris, in medio leviter dilatatis, dein ad apicem longe attenuatis, apicibus late subrotundatis; subtus niger, nitidus, abdomine glabro, pedibus curtis, tarsis subtus ochraceis, prosterni processu tenui.

Patria: Singapore (*Baker*). Long. 4 mm. Lat. 0.9 mm.

This species resembles very much some species of the genus *Aphanisticus.*

Very elongate, glabrous, black, shining, with a small violaceous spot on humeri. Head large; eyes laterally very distinctly prominent; temples short but distinctly developed. Front parallel, nearly 1.25 times longer than wide (from epistome to vertex). On anterior part of head four (two lateral, two median) setiform punctures, the two median ones very approximate. Antennæ black and relatively short. Entire upper surface microscopically shagreened. Prothorax nearly $1\frac{1}{3}$ times wider than long, the greatest width in the middle, rather strongly rounded on sides, with two rather superficial and rather feebly distinct, transverse impressions on disk. Scutellum very small, triangular. Elytra very long, with a long lateral depression behind humeri, moderately broadened behind middle, then long-attenuate and widely rounded on apex. Undersurface black

and shining; median process of prosternum narrow; legs short, femora of hind pair of legs moderately enlarged, undersurface of tarsi yellowish.

Endelus empyreus H. Deyrolle.

In the material of the Baker collection there was only one specimen of this species from Singapore. This species was described from Sumatra, but I have seen specimens of it from Penang also. Rather common in Sumatra.

Genus TRACHYS Fabricius

A large and very difficult genus. The species of *Trachys* occur in rather large numbers in the Palæarctic Region; a large number of species are known from Africa; the largest number live in oriental regions. From America they are known only from the central part, in about four species. A few species occur in Australia.

Thomson [13] has separated a section having a longitudinal carina on elytra and a rather different habitus, under the name *Habroloma*. This carina varies rather greatly; in some species it is short and developed near the humeri only.

The species of this genus are more or less oval or elongate, convex or flattened. Head always rather wide, with a more or less deep concavity in the middle of the front, and with a longitudinal impression. Antennæ rather short, black; in very rare cases (*T. cornuta* Kerremans) the first joint of the antennæ is produced in the form of an elongate tooth. It is remarkable that the second species, with similar character (in my collection, not yet described) comes from Africa—from Fernando Po.

For the systematic study of *Trachys* the form of the head is very important. The antennal cavities are in the form of more or less broad and more or less approximate grooves; therefore, the epistome between them varies very much in width and length. Behind the epistome, which is sometimes divided by a transverse carina from the remainder of the front, are four postoral pores. These pores, surely sense organs, are characteristic for all Trachydini and also for the Agrilini, where they are sometimes modified. Generally, in *Trachys*, only the two middle ones are distinct; the two lateral ones are microscopical, very indistinct, and are situated near the antennal

[13] Skand. Coleop. 6: 42.

cavities. The position and breadth of these two pores are of taxonomic importance in this genus. Their importance will be clearer when it is remembered that in nearly every species of *Brachys*, *Callimicra*, or *Liopleura* (other genera of Trachydini) the position of these pores is characteristic. This minute and not variable character was neglected by the older authors. The second very important and not variable character is the form of the prosternum; it may be wide or long, with parallel or sinuate sides, etc. Also, the color of the tarsi is constant; these (at least the lamellæ) are either black or testaceous.

Specimens of *Trachys* should be mounted on little, elongate, triangular slips to enable one to see the prosternum. The pilosity of the elytra is sometimes rather variable. Because Kerremans makes no mention in his descriptions of the form of the head or of the prosternum, many of his species are of very problematic value.

Key to the species of Trachys Fabricius.[14]

a^1. Elytra with distinct, sometimes very fine, longitudinal carina on the humeri. (Subgenus *Habroloma* Thomson.)

b^1. Humeral carina of elytra short and strong; short, robust, violaceous blue. An arcuate transverse preapical band extending along elytral suture toward scutellum, formed of gray pilosity; 4.5 millimeters. (Luzon.) .... T. luzonica Kerremans.

b^2. Humeral carina finer, long, entire.

c^1. First joint of antennæ strongly widened, produced in the form of a prominent tooth. Head and prothorax dark æneous, nearly black, elytra bright æneous with a dark postmedian transverse band; behind this band on each side with a white, pilose, V-shaped fascia; 3 millimeters. (Luzon.) .... T. cornuta Kerremans.

c^2. First joint of antennæ not dilated or produced, normal.

d^1. Epistome narrowed between antennæ, not transverse.

e^1. Surface above glabrous. Ovate, slightly convex, rounded posteriorly, uniformly black above and beneath. Intercoxal process flat, transverse, sides nearly parallel to posterior angles, which are rounded; 2 millimeters. (Mindanao.) T. glabra Fisher.

e^2. Surface above pubescent.

f^1. Elytral pilosity white or gray.

g^1. Elytral pilosity equal, disposed in fine longitudinal series, denser apically. No transverse fasciæ or designs on elytra. Anterior angles of prothorax with a wide impression. Black, oval-pentagonal; 2.2 millimeters. (Palawan.) .... T. palawana Kerremans.

[14] The following species reported from the Philippine Islands are not represented in this key: *Trachys dubia* E. Saunders, *T. rufescens* Kerremans, *T. bakeri* Kerremans, and *T. fraterna* Kerremans.

g^2. Elytral pilosity unequal.

h^1. Larger, a long, lyriform, glabrous macula common to both elytra. Front narrower, head longer; inner margins of eyes less acute, more produced anteriorly; 2.8 millimeters. (Singapore.) .. **T. conscripta sp. nov.**

h^2. Smaller. Front wider, head shorter, inner margins of eyes sharper, less produced anteriorly. Maculation of elytra irregular; 2.2 millimeters. (Singapore.) **T. speciosella sp. nov.**

f^2. Elytral pilosity yellow or golden.

g^1. Yellow pilosity of upper face very regular, denser; head less produced anteriorly; sides of prothorax more narrowed to apical angles. Front wider. Tarsal lamellæ black. More ovoidal; 2.6 millimeters. (Singapore.) .... **T. uniformata sp. nov.**

g^2. Pilosity of upper surface dense, less regular, a transverse space in middle of elytra nearly hairless. Sides of prothorax more strongly rounded, less narrowed to anterior angles. Front narrower. More cuneiform. Tarsal lamellæ testaceous; 2.8 millimeters. (Borneo.) **T. saundersiana sp. nov.**

d^2. Epistome wide between antennæ, transverse.

e^1. Head without distinct lateral pores in the form of deep pits above base of antennæ.

f^1. Above dark bronze, shining, beneath shining black. Elytra clothed with yellow pilosity, forming three inconspicuous transverse bands, interrupted on suture. Pronotum with a small oblong depression near each posterior angle; clothed with white pubescence; 3.25 millimeters. (Mindanao.) .... **T. metallica Fisher.**

f^2. Greenish æneous; elytra clothed with yellow, subserially disposed pubescence; on each elytron two white maculæ near suture. Pronotum with a depression near anterior angles, clothed with yellow pubescence, with a rather indistinct white spot in front angles; 2.4 millimeters. (Borneo.) **T. sandakana sp. nov.**

e^2. Head with distinct lateral pores in the form of rather large and deep pits above base of antennæ.

f^1. Surface above unicolored.

g^1. The pale elytral pubescence bicolored, white and yellow or pale and brown.

h^1. Larger. Elytral fasciæ very flexuous and distinct in anterior half. Epistome very wide, above separated from front by a fine straight transverse carina; 3.3 millimeters. (Singapore.) ...... **T. singaporensis sp. nov.**

h^2. Smaller. Elytral fasciæ less pronounced, less flexuous. Epistome not separated from front by a transverse carina.

i^1. Head narrower, produced anteriorly. Inner margins of eyes feebly but distinctly prominent in front; epistome a little narrower, the two pores larger and

more distinct. Form more attenuate posteriorly; pronotum with more strongly rounded sides, less attenuate in front. Bright bronzy above, pubescent, black beneath; 3 millimeters. (Mindanao.)
T. philippinensis Fisher.

i^2. Head wider, inner margins of eyes not prominent; epistome wider, the two pores smaller, less distinct. Form elongate and more parallel. Pronotum with less strongly rounded sides, more strongly attenuate in front; 2.9 millimeters. (Borneo.)
T. bakeriana sp. nov.

g^2. The clear elytral pubescence white; apparently hairless spaces covered with a very fine, inconspicuous black pilosity.

h^1. Smaller, black. Epistome narrower; prosternal process much wider than long. Shining; surface covered with a fine, thin, gray, rather unequal pilosity. Inner margins of eyes not prominent; 2.6 millimeters. (Borneo.) .... **T. dajakorum** sp. nov.

h^2. Larger. Dark blue above. Epistome very wide. Prosternal process wide, but distinctly longer than wide.

i^1. Larger, wider, more robust, more flattened. Head less wide, eyes distinctly prominent; prothorax wider, more deeply emarginate at anterior margin; basal angles not prominent, acute. Elytra wider, more flattened. Prosternal process distinctly longer. Legs longer; 3.2 millimeters. (Central Borneo.)
T. praora sp. nov.

i^2. Narrower, smaller, less robust, more convex. Head wider, eyes not prominent anteriorly, prothorax narrower, with less deep emargination at anterior margin; basal angles distinctly produced and prominent posteriorly. Elytra slenderer, more convex. Prosternal process distinctly shorter. Legs shorter; 2.9 millimeters. (Central Borneo.)
T. miana sp. nov.

f^2. Surface above bicolored.

g^1. Sides of pronotum widely flattened. Cuneiform, very much dilated anteriorly; head, pronotum, suture, and posterior third of elytra bronzy; anterior two-thirds of elytra, except suture, dark blue, with a violaceous reflection; pubescent; 3 millimeters. (Mindanao.)
T. cuneiformis Fisher.

g^2. Sides of pronotum not distinctly flattened. Elongate, head and pronotum dark blue; elytra dark violaceous blue, becoming slightly bronzy posteriorly, pubescent; beneath black, with a metallic reflection; 3 millimeters. (Mindanao.) .... **T. mindanaoensis** Fisher.

a^2. Elytra without longitudinal carina along lateral margin. (Subgenus *Trachys* s. str.)[15]

b^1. Intercoxal process wider than long, apex truncate. Oblong-ovate, convex, slightly enlarged anteriorly, rounded posteriorly; above bronzy black, pubescent; beneath black, with a metallic reflection; 4 millimeters. (Mindanao.) .... **T. picta Fisher.**

b^2. Intercoxal process longer than wide, apex rounded.

c^1. Epistome narrow between antennæ, not transverse.

d^1. Surface unicolored.

e^1. Uniform piceous above, with a slight bronzy reflection. Entire anterior two-thirds of elytra rather densely clothed with short, very fine, piceous hairs, with the exception of a few scattered pale yellow hairs near scutellum; entire apical third densely clothed with pale yellow, recumbent hairs, this space with the anterior margin angulate and with a round dark spot on the middle of each elytron at apical fourth; 2.75 millimeters. (Palawan.) .... **T. piceiventris Fisher.**

e^2. Black above, with a slight violaceous reflection. With white and yellow pilose ornamentation on disk of elytra.

f^1. Smaller, more parallel; head narrower; front narrower, with more distinct impression in middle; inner margins of eyes more acute; anterior angles of prothorax less prominent in front, less acute. Elytra less robust, with a long post-scutellar yellow macula on suture, a transverse and post-median fascia, and an apical fascia formed of white hairs; 2.7 millimeters. (Borneo.) .... **T. subaeneella sp. nov.**

f^2. Larger, more attenuate posteriorly. Head a little wider, front distinctly wider; less impressed in middle; inner margins of eyes more obtuse; anterior angles of prothorax more prominent in front and sharper. Elytra more robust; two laterally indistinct transverse yellow fasciæ on basal part, widely joined together on suture, with a white macula laterally; 2.9 millimeters. (Singapore.)

T. scriptella sp. nov.

d^2. Surface bicolored; head and pronotum dark æneous, elytra blue with violaceous reflections, nearly hairless; apical third cupreous and covered with dense yellow pilosity; 2.7 to 2.9 millimeters. (Borneo, Singapore, Palawan.)

T. cupripyga Deyrolle.

c^2. Epistome transverse, wide between antennæ.

d^1. Epistome arcuately emarginate in front.

e^1. Surface above glabrous. Elongate, strongly convex, rounded posteriorly, head and pronotum bronzy black; elytra bright cyaneous, beneath black. Intercoxal process elevated, elongate, wider behind than in front, rounded at tip; 2.9 millimeters. (Leyte.) .... **T. cyanipennis Fisher.**

[15] Here belong also *T. dubia* E. Saunders, *T. rufescens* Kerremans, and *T. bakeri* Kerremans.

*e*². Surface above pubescent.

*f*¹. Color above blue or black, with violaceous luster.

*g*¹. Elytra adorned with a single wide preapical white transverse fascia. Bright blue, with prominent humeri, beneath æneous. Head excavated between eyes; 2⅜ lines. (Central Luzon.) .... **T. princeps** E. Saunders.

*g*². Elytra adorned with three or four very flexuous, narrow, anteriorly rather interrupted transverse fasciæ. Black, with violaceous reflections, feebly shining, rather robust, rather elongate. Humeri only slightly, moderately prominent. Head feebly excavated between eyes; 3.1 millimeters. (Mindanao.) .... **T. fisheri** sp. nov.

*f*². Color above dark bronze, æneous, or cupreous.

*g*¹. Elytra with a V-shaped design; ovate, moderately convex, rounded posteriorly; above dark bronzy, pubescent; beneath black, shining; 4.44 millimeters. (Mindanao.) **T. lunata** Fisher.

*g*². Elytra without V-shaped design.

*h*¹. Surface covered with sparse white pilosity, without intermixed yellow or reddish brown recumbent hairs; remaining surface of elytra hairless, shining, without recumbent black hairs. Brassy; 2.5 millimeters. (Penang.) .... **T. isolata** sp. nov.

*h*². Surface covered with white and yellow or with white and reddish brown pilosity.

*i*¹. Pronotum clothed with white and dark reddish pilosity; elytra covered with long, very slender, black hairs, intermixed with broader silvery white recumbent ones, the white hairs forming irregular designs on anterior half and a double transverse zigzag row at apical third. Eyes rather strongly margined on inner sides. Sides of pronotum rather flattened. Oblong-ovate, head of slight bronzy color, pronotum and elytra piceous, the former with bronzy reflections; 3.65 millimeters. (Mindanao.) **T. marmorata** Fisher.

*i*². Pilosity of pronotum and of elytra of the same color.

*j*¹. Æneous, more equally covered with yellow pubescence; the white maculæ between the yellow hairs rather indistinct. Smaller, wider, more rounded apically. Prosternal process wide, flattened, distinctly dilated apically, rounded at tip. Palpi and tarsi testaceous; 2.6 millimeters. (Borneo.) **T. eschscholtzi** sp. nov.

*j*². Darker æneous to cupreous, with less equal and less dense pilosity; the fasciform white ornamentation is much more distinct. Larger, more elongate and more convex.

*k*¹. Sides of pronotum narrowed to anterior angles in a nearly straight line. More robust, with seven

small white spots on pronotum. Prosternal process narrower, a little dilated at tip. Tarsi dark brown; 3 millimeters. (Formosa, Luzon.)
T. formosana Kerremans.

k^2. Sides of pronotum narrowed to anterior angles in a feebly but distinctly rounded line. Pronotum with two or three indistinct white spots. Slender. Prosternal process wider, with parallel sides. Tarsi and palpi testaceous; 3 millimeters. (Mindanao.)... **T. dapitana** sp. nov.

d^2. Epistome rectangularly marginate in front.

e^1. Tarsal joints black. Form ovate, rounded posteriorly. Head and pronotum dark bronzy, beneath black; elytra piceous, with bronzy reflection; 2.5 millimeters. (Luzon.)
T. ovata Fisher.

e^2. Tarsal joints yellow. Form ovate, rather wide. Head and prothorax green, elytra black with æneous reflections; 2.75 millimeters. (Manila, Luzon.).......... **T. viridula** Kerremans.

Trachys (subg. **Habroloma**) **conscripta** sp. nov. Plate 4, fig. 32.

Obscura, olivaceo aenea, partibus glabris elytrorum paullo obscuratis. Parum convexa, cuneiformis, satis supra deplanata. Carina elytrali tenui distincta. Capite medio late depresso, oculis satis fortiter anguloso productis, sed solum paullo magis prominentibus quam anguli thoracis anteriores. Fronte medio leviter impressa pilis raris albosericeis inaequaliter tecta, oculorum marginibus interioribus ad epistoma satis fortiter convergentibus. Poris mediis postoralibus duo similiter quam antennarum cavitatibus valde approximatis, epistomate valde attenuato. Antennis nigris, articulis quinque apicalibus triangularibus, satis dilatatis. Thorace lato, lateribus postice subparallelis, ad angulos anticos late rotundato, angulis antici satis productis. Superficie sparse ac subtiliter, satis inaequaliter albosericea. Elytris ad apicem satis fortiter attenuatis, antice satis rugoso sculptis, humeris paullo prominulis. Superficie tota sparse ac aequaliter, subseriatum albosericea; solum macula magna communi lyriformi ac macula utrinque parva rotunda praeapicali glabris (seu indistincte obscure pilosis). Corpore subtus pedibusque nigris, nitidis, glabris. Prosterno lato ac brevi, ad apicem dilatato. Segmento anali apice linea profunda marginato. Unguiculis parvis, dentatis.

Patria: Singapore (*Baker*). Long. 2.8 mm. Lat. 1.8 mm.

Rather dark brassy colored, with a feeble olivaceous luster; the hairless parts of elytra a little obscurate. Body rather elongate, cuneiform, rather attenuate to apex. Head rather flattened on middle, with a rather feeble median impressed

line, eyes rather strongly prominent laterally, but not much exceeding anterior margins of prothorax. The two median post-oral pores are very approximate, as are the antennal cavities; they are approximated in such a way that the epistome is very narrow between them. Prothorax wide, with nearly parallel basal portion of sides, anteriorly very strongly rounded with rather prominent anterior angles. Entire surface covered with a very fine, silky, white pilosity, which is rather unequal. Sculpture consists of the sides of circles. Scutellum small, triangular, and hairless. Elytra rather long, rather strongly attenuate to apex, with a fine, distinct humeral carina, with rather prominent, hairless shoulders; entirely covered by a very fine, silky, white, serially disposed pilosity; only a large macula, common to both elytra, in the form of a lyre, is hairless and a little obscurate. There is also one (sometimes two) small rounded preapical hairless space on elytra. The seemingly hairless spaces are in reality covered by fine, obscure, nearly invisible pilosity. Undersurface and legs black, hairless, shining.

The single type in the Baker collection bears the number 12624.

Trachys (subg. **Habroloma**) **speciosella** sp. nov. Plate 4, figs. 27, 33.

Speciei *conscripta* sp. nov. simillima ac ab ea praecipue, uti sequitur divergens: Forma simili, sed corpore multo minore, fronte multo latiore, capite breviore, cavitatibus antennarum minoribus, oculis acutius, sed minus longe productis, elytris simillibus, unicoloribus, obscure aeneis, albopilosis, maculis irregularibus glabris. Corpore subtus similiter instructo. Maxime fronte multo latiore ac ad anticem minus attenuata ac elytrorum ornamentatione valde divergens.

Patria: Singapore (*Baker*). Long. 2.2 mm. Lat. 1.2 mm.

Very similar to *Trachys conscripta* sp. nov., but smaller; head shorter, eyes in the same line as anterior angles of prothorax; front wider than in *T. conscripta*, less attenuate anteriorly, the antennal grooves smaller; eyes more acutely but more shortly prominent. Elytra similar, but the ornamentation, which is very distinct and well separated from the hairless spaces in *T. conscripta*, is here confused, indistinct; elytra unequally covered by silky, white pilosity, with some irregular, hairless spaces. Undersurface as in *T. conscripta*.

A single specimen of this species is in the Baker collection.

Trachys (subg. Habroloma) uniformata sp. nov. Plate 4, fig. 34.

Aenea, satis robusta, satis convexa, cuneiformis, longe ovalis. Superficie tota pilis aureis aequaliter tecta. Carina humerali distincta. Capite haud prominulo, satis parvo, fronte in medio longitudinaliter impressa, poris postoralibus duo satis distantibus, epistomate satis lato, satis longo. Cavitatibus antennarum satis distantibus. Thorace lateribus ad anticem fortiter rotundatim-attenuatis, haud fortiter deplanatis, angulis anticis haud prominentibus, angulis posticis acutis. Elytris latitudine fere 1½ longioribus, apice satis late rotundatis, sub pilositate lutea satis rugulosis. Prosterno lato, brevi, ad apicem dilatato. Corpore subtus pedibusque nigris, glabris nitidis. Unguiculis parvis, dentatis, tarsis nigris.

Patria: Singapore (*Baker*). Long. 2.6 mm. Lat. 1.7 mm.

Rather robust, rather convex, elongate, cuneiform; apex of elytra rather widely rounded. Entire upper surface covered with a very equal, not dense, fine, thin, yellow or golden pilosity. Head rather small, with not prominent eyes, and with a feeble median impression; front rather narrow, the two postoral median pores rather distant; epistome rather long and rather wide. Antennal grooves rather distant. Prothorax rather convex, with only feebly flattened sides, on sides rather strongly and, in a rounded line, attenuate to anterior angles which are not prominent; posterior angles very acute. Elytra on entire upper surface brassy and pilose, the sculpture rather indistinct under the pilosity and rather rugose. Undersurface black, hairless, shining. Prosternum wide and very short, enlarged apically. Legs and antennæ black. Last ventral segment margined at tip with a deep, impressed line. Claws small, and with a distinct tooth.

The single type bears the number 12620.

Trachys (subg. Habroloma) saundersiana sp. nov. Plate 4, fig. 37.

Parva, nitida, nigro-aenea, satis convexa, cuneiformis. Superficie tota pube aequali subtili aurea tecta; scutello solum ac macula transversa ovali communi in elytrorum medio glabrata. Capite satis parvo, fronte in medio depressa, oculis haud prominulis; poris postoralibus duo mediis valde approximatis, epistomate tenui, restricto. Thorace in parte basali solum leviter, antice fortiter rotundatim attenuato, angulis anticis modice productis leviter impressis. Elytris satis longis, carina humerali

distincta, sculptura antice in parte humerali satis rugosa. Corpore subtus nigro, nitido, glabro, prosterno lato ac brevi, apice dilatato. Segmento anali apice linea, profunda, tenui, impressa marginato.

Patria: Borneo, Sandakan (*Baker*). Long. 2.8 mm. Lat. 1.5 mm.

Rather small, shining, of brassy black color; rather convex, cuneiform. Entire upper face covered with a fine, thin, golden, equal pilosity; only scutellum and a median, transverse, oval macula, common to both elytra, hairless (in reality covered with nearly invisible dark hairs). Head rather small; impressed in the middle, with not prominent eyes. The two median postoral pores very approximate; epistome very narrow. Prothorax wide, rather strongly rounded anteriorly, with a depression in anterior angles which are rather prominent and acute. Elytra with moderately prominent humeri, with a distinct, entire, fine carina. Sculpture rather rugose on anterior part. Prosternum very wide and short, enlarged apically. Undersurface black, hairless, shining. Claws small, with a fine tooth.

The single type, numbered 13793, is in the Baker collection.

Trachys (subg. **Habroloma**) **sandakana** sp. nov. Plate 4, fig. 31.

Viridi-aenea, satis nitida, corpore supra pilis luteis sparsis ac suberectis, in elytris subseriatim dispositis tecto; solum in elytris, ad suturam maculis duo (quattuor) albosericeis, paullo densioribus ornatis. Thorace in angulis anticis similiter ornato. Corpore elongato, satis plano. Capite curto, medio depresso, oculorum marginibus satis prominentibus, thoracis margines anteriores haud superante, epistomate satis lato, apice truncato, haud emarginato, poris mediis postoralibus distantibus. Thorace lateribus ad anticem attenuatis, in parte anteriori valde rotundatis ac lateribus anterioribus acute prominentibus. Margine anterior valde rotundatim emarginato. Scutello minutissimo, triangulari. Elytris subconicis, ad apicem fortiter attenuatis, latitudine circiter $1\frac{1}{3}$ longioribus. Prosterno latissimo, dilatato ac curto, nitido. Corpore subtus pedibusque nigris, nitidis. Segmento anali apice linea profunda semilunari marginato.

Patria: Borneo, Sandakan (*Baker*). Long. 2.4 mm. Lat. 1.3 mm.

Rather slender, moderately convex, rather shining, of a greenish brassy color. Entire upper surface covered with fine, sparse, yellow hairs disposed on elytra in longitudinal series.

Near suture, on elytra, there are two (four) silky, white, more densely pilose spaces; anterior angles of prothorax are marked with similar maculæ. Head flattened and short, lateral margin with eyes strongly prominent, but not longer than anterior prominent angles of prothorax. Epistome rather wide, truncate to anterior angles; anterior part of sides strongly rotundate and angles prominent. Elytra nearly 1⅛ times as long as wide and strongly attenuate and rotundate to apex, with distinct, fine humeral carina. Elytral sculpture rather rugose and covered by the pilosity. Undersurface, antennæ, and legs hairless, shining, and black; prosternum very short and very wide, enlarged at tip; last ventral segment marginate at tip with a very fine, deep semilunar line.

The single specimen in the Baker collection is numbered 12634.

Trachys (subg. Habroloma) singaporensis sp. nov. Plate 4, fig. 35.

Affinitatis *T. lepidoptera* Kerremans, *amica* Kerremans, et *gentilis* Kerremans. Eadem forma ac colore, ab eis uti sequitur differens:

Colore ac forma speciei sumatrensi *lepidoptera* Kerremans maxime affinis, sed capite maiore, medio late, sed distinctius excavato, thorace multo latiore, angulis anterioribus multo magis prominentibus, lateribus multo fortius rotundatis, prosterno lato, uti apud *lepidopteram* ac forma simili, sed multo longiori. Epistomate brevi ac latissimo, antennarum cavitatibus valde distantibus.

A speciebus *amica* ac *gentilis* iam forma ac colore valde diffinis.

Patria: Singapore (*Baker*). Long. 3.3 mm. Lat. 2.2 mm.

This species resembles very much *T. lepidoptera* Kerremans from Sumatra, in color and size. *Trachys amica* and *T. gentilis* of the same author are also very similar.

Of the same color and size as *T. lepidoptera.* Head wider, with a very wide but more distinct median depression. Prothorax of much greater width, with more strongly prominent anterior angles, which are situated nearly in the same line as the anterior margins of eyes. Sides of prothorax more rounded and more strongly attenuate to anterior angles. Prosternum of a similar form but distinctly longer. Undersurface formed as in *T. lepidoptera.*

The two other species mentioned are distinctly different by their size and coloring. It is the one species of this group

with very wide and short epistome. It seems to be rather common, because there were several specimens in this collection. I have compared this species with the types and paratypes of the other species in my collection.

Trachys (subg. Habroloma) philippinensis Fisher. Plate 4, fig. 30.

I have seen only a single specimen of this species, coming from Dapitan, Mindanao (*Baker*). This species is a good example of the forms with rather wide and short epistome and with distant median postoral pores.

Trachys (subg. Habroloma) bakeriana sp. nov. Plate 4, fig. 36.

Parva, satis convexa, cuneiformis, postice ovata, corpore speciei *uniformata* sp. nov. affinis. Superficie satis inaequaliter, subtiliter aureo pilosa, in elytrorum parte praeapicali fasciis duo albidis transversis satis indistinctis ornata. Aeneo nigra, satis nitida. Capite medio late, haud profunde impresso, oculis haud prominentibus, poris mediis postoralibus distantibus, epistomate brevi ac lato. Antennarum cavitatibus distantibus. Thorace lateribus haud fortiter deplanatis, in angulis anterioribus impressis, lateribus ad anticem satis fortiter rotundatim attenuatis, angulis anticis satis prominentibus, acutis, angulis posticis acutis. Prosterno brevi, lato, ad apicem dilatato. Elytris carina humerali distincta. Corpore subtus pedibusque nigris, fere glabris, margine segmentis analis apice linea profunda impressa marginato.

Patria: Borneo, Sandakan (*Baker*). Long. 2.9 mm. Lat. 1.7 mm.

Rather small, rather convex, cuneiform, rather ovate near apex. Resembles rather strongly *T. uniformata* sp. nov. Entire upper surface covered with a rather unequal, fine, golden, thin pilosity; on apical half of elytra with two transverse, straight, rather indistinct white fasciæ. Black with a brassy luster. Head in middle rather widely but not deeply impressed. Eyes not prominent. The two median postoral pores are strongly distant; epistome short and wide. Prothorax wide, rather convex, with only feebly flattened sides, with an impression in anterior angles which are rather prominent and acute. Surface of prothorax rather unequally pilose. Elytra generally formed as in *T. uniformata*, with fine, entire carina. Undersurface black, shining, nearly hairless. Prosternum very short and wide, dilated apically. Last ventral segment entirely margined at tip with a fine, deep, impressed semicircular line. Legs

and antennæ black, tarsi black, claws small, with a distinct, fine tooth.

The two specimens in the Baker collection were numbered 12636 and 13797.

Trachys (subg. **Habroloma**) **dajakorum** sp. nov. Plate 4, figs. 28, 29.

Nigra, nitida, elongata. Corpore supra sparsim, satis inaequaliter pube molli, tenui, grisea tecto; pilositate hac in elytris fascias duo transversales satis irregulares formante. Capite satis magno, lateribus oculorum (desuper observatis) rotundatis, oculis haud prominentibus, poris postoralibus lateralibus (in figura "l") cum illis mediis ("m") transverse conjunctis. Epistomate satis attenuato. Thorace lateribus postice fere parallelis, antice valde rotundatis, angulis anticis acutis, sed haud prominulis, margine thoracis anteriori valde rotundatim emarginato; thoracis superficie modice convexa, prope angulos anteriores impressione rotundata satis profunda; superficie nitida, ante basim ac ad latera sculptura tenuissima circulari. Scutello parvo triangulari. Elytris latitudine fere 1½ longioribus, ad apicem satis fortiter attenuatis ac ibi rotundatis, carina tenui humerali distincta. Sculptura satis rugosa. Prosterno curto ac latissimo. Corpore subtus pedibusque nigris, nitidis, glabris. Segmento anali margine exteriori linea impressa profunda marginato.

Patria: Borneo, Sandakan (*Baker*). Long. 2.6 mm. Lat. 1.5 mm.

Black and shining. Elongate; entire upper surface covered with a fine, thin, gray, rather unequal pilosity, which makes two wide, transverse, not very dense fasciæ on the elytra. Head rather large, inner margins of eyes (observed from above) rotundate, not prominent; front rather wide, with a median impression, the two postoral lateral pores (in the figure, *l*) and the two median pores (*m*) united by a deep transverse impression. Epistome rather narrow. Prothorax nearly parallel on basal part, anteriorly strongly rotundate, anterior angles not prominent; anterior margins rather strongly and widely emarginate. Prosternum very wide and very short. Elytra nearly 1.5 times as long as wide, rather strongly attenuate to apex, where they are together rounded. A distinct entire humeral carina is developed. Undersurface and legs black, shining, hairless. Anal segment on exterior sides entirely margined with a fine, impressed, semicircular line. Claws small, with a distinct tooth.

I have seen only a single specimen of this species, numbered 12637 in the Baker collection.

Trachys (subg. **Habroloma**) **praora** sp. nov. Plate 4, fig. 38.

Speciei *miana* sp. nov. valde affinis, eodem colore ac pilositate, atque solum, uti sequitur, differens:

Multo latior, maior, robustior. Pedibus distincte multo longioribus, oculis haud fortiter, sed distincte prominentibus. Angulis anterioribus thoracis multo minus prominentibus. Thoracis angulis basalibus haud prominentibus; thorace distincte latiore, ad angulos anteriores similiter impresso. Capite minus lato; epistomate minus dilatato, brevi. Prosterno lato ac brevi, sed distincte longiori. Elytris multo latioribus ac magis deplanatis.

Patria: Central Borneo (*Boháč;* coll. *Obenberger*). Long. 3.2 mm. Lat. 2 mm.

This species resembles *T. miana* sp. nov. very much and can be easily distinguished by the following characters:

Larger, more robust, but more flattened. Color and pilosity generally similar. Head less wide, more distinctly depressed; eyes distinctly prominent. Prothorax wider, more deeply emarginate at anterior margin; basal angles not prolonged or prominent, acute. Elytra much wider, more flattened. Prosternal process similar, wide, but distinctly longer. Legs very distinctly longer.

I have in my collection a single specimen of this species.

Trachys (subg. **Habroloma**) **miana** sp. nov. Plate 4, fig. 39.

Coeruleo-violacea, satis obscura, forma speciei *Trachys amica* Kerremans (Sumatra) affinis.

Capite lato, medio late impresso, oculis haud prominulis, oculorum marginibus interioribus acutis. Fronte lata, sparse albopilosa poris postoralibus duo mediis valde distantibus, epistomate lato ac brevi. Thorace lato, sparse ac irregulariter albopiloso, antice valde emarginato, angulis basalibus acutis, prominentibus, anticis acutis, modice prominulis. Lateribus fortiter rotundatim attenuatis. Thorace ad angulos anticos profunde impresso. Elytris haud fortiter nitentibus, satis longis, carinatis, fasciis nonnullis valde flexuosus pilorum albosericeorum ornatis.

Patria: Borneo centralis (*Boháč* leg.; coll. *Obenberger*). Long. 2.9 mm. Lat. 1.8 mm.

Head wide, with small, not prominent eyes; in the middle with a distinct, very wide depression; front wide, irregularly, finely, sparsely covered with a silky, white pilosity; the two postoral median pores very distant; epistome very short and wide. Prothorax wide, with deep emargination on anterior margin; anterior angles acute and rather strongly prominent; basal angles very acute, very distinctly prominent; near anterior angles is a deep impression. Prosternum very short and wide, impressed in the middle and enlarged apically. Elytra of the form of *T. amica*, covered with some very flexuous transverse fasciæ, which are rather discontinuous on anterior half and which consist of fine, thin, silky, white pilosity. Humeral carina entire, distinct. The seemingly hairless spaces of the surface are in reality covered with a very dark and rather dense, obscure, feebly distinct pilosity. Undersurface and legs hairless and shining, black. Legs rather long. Last ventral segment entirely margined at tip by a deep, impressed, semicircular line.

Trachys (s. str.) **picta** Fisher. Plate 1, fig. 31.

The single specimen of *Trachys picta* in the Baker collection, numbered 13801, comes from Dapitan, Mindanao. This species is very remarkable for the very short and wide prosternum and for the form of the epistome; this is posteriorly separated from the front by a small transverse carina; it is very short and wide; postoral pores distant.

Trachys (s. str.) **subaeneella** sp. nov. Plate 1, fig. 27.

Nigra, nitida, paulo violaceo nitens. Corpore satis deplanato, haud robusto. Capite lato, luteo regulariter piloso, angulis interioribus oculorum acutis. Fronte lata, medio late impressa, poris postoralibus satis approximatis, epistomate tenui. Thorace lato, antice valde emarginato, lateribus ad anticem haud fortiter rotundatis; superficie tota aequaliter pilosa, pilis his medio luteis, lateribus albidis, tenuibus. Scutello parvo triangulari. Elytris latitudine fere $1\frac{1}{2}$ longioribus, satis plane convexis, nitidis, humeris parum elevatis; ad humeros latitudine maxima, ad apicem primo fere subparallelis, dein modice rotundatim attenuatis; nitidis macula pilosa triangulari scutellari lutea, fascia praeapicali alba ac apice albo ornatis. Macula hac lutea extus etiam pilis aliquot albidis marginato. Superficie alio pilis nigris, fere invisibilibus tecta. Prosterno satis lato subparallelo, apice rotun-

dato, marginato. Corpore subtus pedibusque nigris, glabris. Palpis ac tarsisque subtus testaceis, unguiculis parvis, distincte dentatis.

Patria: Borneo, Sandakan (*Baker*). Long. 2.7 mm. Lat. 1.6 mm.

Rather elongate, moderately convex, not robust, black, shining. Head wide, with a fine, equal, yellow pilosity. Postoral pores rather approximate; therefore the epistome is rather narrow. Prothorax wide, rather convex, with strongly emarginate anterior margin, sides moderately rounded to apex, entirely covered with a fine, equal pilosity which is white on sides and yellow on the large median part. Scutellum small and triangular. Elytra black, shining, nearly 1.5 times as long as wide, the greatest width near the humeri, then moderately, regularly rounded to apex; surface adorned with a pilose ornamentation which forms a long, triangular, postscutellar yellow macula on suture, one transverse postmedian fascia and an apical fascia, both of silky, white pilosity; sutural yellow macula exteriorly marked with some white hairs. Prosternum parallel, rather wide, rounded at tip, and marginate. Undersurface and legs black, hairless, shining; palpi and tarsi testaceous. Claws finely toothed, small.

There were two specimens (numbered 12635 and 13796) in the Baker collection. Their ornamentation and the form of the head and prosternum distinguish them easily from the other similar species.

Trachys (s. str.) scriptella sp. nov. Plate 1, fig. 28.

Speciei *subaeneella* sp. nov. valde affinis, maior, ad apicem magis attenuata, oculis minoribus, eodem colore, elytris aliter pilosis: pilis luteis fascias duo lateraliter satis indistinctas ac in sutura late conjunctas formantibus; lateribus pube alba admixta. Fronte similiter formata, solum latiore, ac paullo minus fortiter canaliculata, marginibus interioribus oculorum minus acutis. Abdomine robustiore, prosterno satis lato, subparallelo, marginato. Angulis anterioribus thoracis magis prominentibus. Pedibus similiter quam apud speciem *subaeneella* formatis.

Patria: Singapore (*Baker*). Long. 2.9 mm. Lat. 1.7 mm.

This species resembles very much *Trachys subaeneella* sp. nov., and differs only in the following characters: Head a little wider; front similar but wider, less impressed in the middle; inner margin of eyes less acute; prothorax of a similar form,

but the anterior angles more prominent and more acute; prosternum nearly parallel, rounded at tip, and margined laterally. Elytra more robust, more attenuate laterally to apex; the ornamentation entirely different, being composed of two laterally indistinct transverse yellow fasciæ on basal part of elytra, on suture widely joined together, on sides joined to a silky, white macula, all pilose spaces covered with fine, thin hairs. Abdomen and undersurface similar to *T. subaeneella.*

In the Baker collection there were only two specimens of this species. One was numbered 12619.

Trachys (s. str.) **cupripyga** H. Deyrolle. Plate 1, fig. 25.

A species with a very wide geographic distribution. The specimen before me, numbered 11623, was taken at Singapore (*Baker*).

Trachys (s. str.) **fisheri** sp. nov. Plate 1, fig. 30.

Nigro-violacea, parum nitida; corpore satis elongato ac supra satis depresso. Capite lato, satis robusto, oculis haud prominulis; fronte lata in medio satis fortiter impressa, poris postoralibus satis distantibus, nec non usque ad latera positis, epistomate brevi ac lato. Thorace minute sculpto, punctis minutis sparsis ornato, uti caput sparse albopubescente. Scutello minimo, fere invisibili. Elytris longtudine latitudinem $1\frac{2}{5}$ superantibus, usque ad medium fere subparallelis, dein ad apicem rotundatim attenuatis, minute sculptis, satis pilosis, fasciis tenuibus valde sinuatis, satis interruptis pilorum albosericeorum ornatis. Corpore subtus, pedibus antennisque nigris, nitidis, glabris; palpis ac tarsis brunnescentibus. Prosterno lateribus marginatis, haud lato, ad apicem dilatato ac ibi rotundato.

Patria: Mindanao, Iligan et Dapitan (*Baker*). Long. 3.1 mm. Lat. 1.7 mm.

Rather robust, feebly shining, rather long, and somewhat depressed. Color similar to *Trachys miunta* Linnæus, black with violaceous luster. Head rather robust and wide, with simple eyes; inner margins of eyes not acute. Front in middle rather deeply longitudinally impressed, the two postoral pores large and rather distant, but a little distant from lateral margin of front. Epistome short and wide. Antennæ black. Prothorax wide, with rather deep emarginate anterior margin, anterior angles not prominent, and with sides regularly attenuate in a rounded line to anterior angles. Surface rather finely sculptured, but the

sculpture rather indistinct under the pilosity, only some minute punctures perceptible on sides. Head and pronotum sparsely covered with fine, silky, white pilosity. Elytra about 1.4 times as long as their joint width, nearly parallel-sided to middle, and then rounded to apex; rather feebly shining, rather feebly convex, with moderately prominent shoulders; covered with a pilosity which forms some very flexuous, narrow, undulate, often interrupted, transverse, silky, white fasciæ. The hairless shining surface is in reality covered with a very indistinct and nearly invisible dark pilosity. Scutellum indistinct, very small. Prosternum a little enlarged in apical part and rounded at tip, emarginate, rather narrow. Undersurface black and hairless, palpi and tarsi brown.

Dedicated to Mr. W. S. Fisher, who has published a paper on the Philippine Buprestidæ. There were only two specimens of this species in the Baker collection. The one from Iligan is numbered 13799.

Trachys (s. str.) isolata sp. nov. Plate 1, fig. 26.

Broncea, satis nitida, satis convexa. Capite lato, in medio longitudinaliter impresso, epistomate satis lato, poris postoralibus satis distantibus. Antennis nigris. Thorace lato, nitido, glabro, sculptura indistincta circulorum parvorum ac superficialium. Lateribus ad anticem fere in linea recta valde attenuatis, postice brevissime subparallelis, angulis posticis satis acutis. Scutello parvo triangulari distincto. Elytris satis irregulariter ac satis fortiter, punctatis, fasciis aliquot undulatis, valde indistinctis pilorum albosericeorum. Elytrorum forma haud robusta, humeris parum prominentibus, elytris ab humeris ad apicem subsinuatim ac rotundatim attenuatis ac apice conjunctim rotundatis. Corpore subtus pedibusque nigris. Prosterno attenuato, subparallelo, apice parum, sed distincte dilatato, lateribus subtilissime marginatis. Unguiculis minutis ac dentatis, tarsis nigris.

Patria: Penang Island (*Baker*). Long. 2.5 mm. Lat. 1.3 mm.

Small, brassy, rather shining. Head wide; front above, at upper margins of eyes, wider than length of an eye. Postoral pores rather distant, epistome rather wide. Antennæ black. Prothorax wide, rather shining, with a very fine, only feebly distinct sculpture, consisting of fine circles; hairless. Scutellum very small and triangular. Elytra not robust, the greatest width at shoulders, then sinuate and attenuate to apex, where they are

conjointly rounded; some discontinued and feebly indicated undulated fasciæ of silky, white hairs on surface; sculpture consists of rather superficial and rather large irregular puncturation, without distinct shagreening or striæ. Prosternum narrow and slightly, distinctly enlarged at tip, laterally finely marginate. Claws feeble, with a distinct tooth. Legs with tarsi and undersurface black, hairless.

In the Baker collection there was a single specimen of the present species, numbered 12622.

Trachys (s. str.) eschscholtzi sp. nov. Plate 1, fig. 32.

Satis elongata, subconvexa, ovalis, haud robusta, supra aenea, satis nitens, superficie tota pube aurea ac huc et ubi brunnescente tecta; solum in thoracis medio, ante scutellum ac thoracis lateribus pilis nonnullis albidis ornatis. Elytris maculis simillibus subtransversis pilorum albosericeorum quattuor (octo) ornatis. Pilis mollibus ac tenuibus. Capite lato, magno, in medio late depresso; poris postoralibus valde distantibus, epistomate curto ac lato alutaceo. Thorace satis lato, lateribus ad anticem fere recte attenuatis, angulis posticis haud prolongatis, angulis anticis modestis, margine anteriori latissime emarginato. Scutello minutissimo, triangulari. Elytris latitudine fere 1½ longioribus, humeris leviter prominulis, elytrorum lateribus usque ad medium parum, dein magis fortiter ac rotundatim attenuatis, apice conjunctim rotundatis, modice convexis, satis nitentibus, dense pilosis. Prosterno satis lato, apice paullo dilatato ac rotundato, marginato, nitente. Unguiculis parvis, late dentatis. Corpore subtus, antennis pedibusque nigris, palpis ac tarsis testaceis. Impressione laterali prosternali parva.

Patria: Borneo, Sandakan (*Baker*). Long. 2.6 mm. Lat. 1.7 mm.

Rather small, ovoid, rather elongate, rather feebly convex. Entire upper surface covered with a dense, fine, equal, yellow, in some places brownish pilosity. There are some spaces covered with similar but silky, white hairs. In the middle (before scutellum) and on sides of prothorax, are four (eight) transverse, not too distinct maculæ along suture on elytra. Head very wide and rather robust; eyes not prominent, rather small; postoral pores very distant; epistome short, wide, shagreened. Prothorax short and wide, laterally rather strongly and, in a nearly straight line, attenuate to apex; anterior margin very widely emarginate. Scutellum very small, triangular. Elytra about 1.5 times as long as wide, rather feebly convex, rather shining; sculpture

under the pilosity indistinct; sides very feebly (to the middle), then more strongly and in a rotundate line attenuate to apex, where they are rather widely rounded. Prosternum rather wide, a little enlarged in apical part and rounded at marginate tip. Entire undersurface, antennæ, and legs black, shining, hairless; palpi and tarsi testaceous. Claws black, small, and with a wide tooth.

A single specimen numbered 13795 is in the Baker collection.

Trachys (s. str.) **formosana** Kerremans.

I have compared the next species with two paratypes of the present species in my own collection, coming from Formosa (*Sauter*).

Trachys (s. str.) **dapitana** sp. nov. Plate 1, fig. 29.

Violaceo-aenea, satis nitida; capite ac thorace satis inaequaliter luteo piloso, elytris inaequaliter, haud dense luteo pilosis cum aliquot pilis albis intermixtis. Capite satis lato, in medio satis fortiter impresso, poris postoralibus lateralibus satis distantibus, epistomate satis lato. Antennis nigris. Oculis satis parvis, haud prominulis. Thorace angulis anticis haud productis, lateraliter ad anticem arcuatim satis fortiter attenuato, angulis posticis haud prominentibus, superficie satis convexa, nitida. Scutello minutissimo triangulari. Elytris haud robustis, satis plane convexis, longitudine latitudinem $1\frac{1}{2}$ superante, usque ad medium insensibiliter, dein ad apicem rotundatim attenuatis. Sculptura elytrorum satis superficiali, punctis aliquot perminutis intermixtis. Prosterno subparallelo, satis lato, marginato. Corpore subtus nigro, glabro, nitido. Palpis ac tarsis subtus rufotestaceis.

Patria: Mindanao, Dapitan (*Baker*). Long. 3 mm. Lat. 1.5 mm.

Rather elongate and rather depressed. Brassy with a violaceous luster, rather shining, head and prothorax covered with unequal, yellow pilosity. Head rather wide, with a rather strong median impression; the two postoral lateral pores rather distant, epistome rather wide. Antennæ and legs black. Eyes rather small and not prominent. Prothorax rather wide, anterior angles not prominent; surface rather shining and rather convex. Scutellum very small and triangular. Elytra rather elongate, nearly 1.5 times longer than wide, in anterior part nearly parallel-sided, then in a rounded line attenuate to apex; covered with unequal, not dense, simple pilosity, consisting of yellow and some intermixed white hairs; sculpture fine, surface rather shin-

ing; between the single punctures appear also extremely fine punctures. Prosternum rather wide and parallel, with marginate sides. Undersurface black and shining, hairless, palpi and tarsi red testaceous.

The single specimen before me is numbered 13800.

Genus **PARATRACHYS** E. Saunders

This genus seems to be nearer to *Ianthe* than to the other genera occurring in the Oriental Region. The species of this genus are always rather rare. Nearly all are characteristized by the peculiar striate sculpture of the elytra and by different radially pilose ornamentations. The present species resembles a little *P. pilifrons* Kerremans, which I have in my collection from Sumatra.

In the Baker collection there is a single specimen of a new species of this genus.

Paratrachys bakeri sp. nov. Plate 1, fig. 8.

Niger, satis nitidus, ovalis, in $\frac{2}{5}$ anterioribus corporis latitudinem maximam attingens, postice rotundatus. Capite lato ac plano, dense punctato ac sparse albosericeo. Thorace convexo, lato, dense punctato, nitido, lateribus ad anticem oblique attenuatis, margine anteriori late circulatim emarginato. Elytris longe ovalibus, satis latis, longitudine latitudinem solum $\frac{1}{5}$ superante, in parte humerali leviter dilatatis, ad apicem valde rotundatis, apicibus satis late conjunctim rotundatis. Elytrorum superficie dense oblique strigoso striata. Elytrorum ac thoracis superficie tota obscure-erecte pilosa; inter pilositatem hanc ornamento pilorum albosericeorum, quod ellipsam regularem efficit, cujus pars superior (semicircularis) in thorace, pars inferior in elytris posita est, ellipsae huius pili dense ac radialiter dispositi sunt; in elytrorum parte apicali, inter illam ellipsam ac apicem vitta similis, semielliptica, similiter instructa posita est. Scutello triangulari, parvo, laevi. Prosterno lato, lateribus paullo dilatatis abdomine dense ac subtiliter albosericeo. Corpore subtus pedibusque nigris.

Patria: Singapore (*Baker*). Long. 3 mm. Lat. 2.1 mm.

Black, rather shining, oval; greatest width on two-fifths of the length of the entire body. Head rather flattened, rather densely and finely punctured, covered with fine, sparse, silky, white pubescence. Prothorax convex and with margins in an even line with those of elytra; rather densely punctured and rather shining. Elytra rather convex, as in some *Pachyschelus*

species, one-fifth longer than wide, conjointly rounded at apex; surface finely, densely, obliquely striate, the striæ sharp and strigose. Entire surface of prothorax and elytra covered with pilosity which is dark and black on the seemingly glabrous spaces, and the ornamentation consists of fine and rather adherent radial, silky, white pilosity. The white ornamentation forms an elongate ellipse common to both elytra, one part on prothorax, the other on elytra; between this ellipse (which reaches behind middle of elytra) and apex is a similar half-elliptical vitta, which is more attenuate to the humeri. Prosternum wide and a little before apex. Abdomen covered with very fine, dense, silky, white pilosity. Undersurface and legs black.

This is one of the most interesting species sent to me by Baker. It is very different from all species known to me. The single specimen (type) has the number 12607.

Genus PACHYSCHELUS Solier

Most described species of this genus inhabit South America. Only three are found north of Mexico. A single species is known from Madagascar, another from Africa, and one from the Palæarctic Region (Algeria). Only very few have been described from the Oriental Region, and most of them occur on the large islands. Recently I received one species from Tonkin (*Pachyschelus bedeli* Obenberger). The males of this genus are marked with some peculiar little combs on the apical margin of the anal segment. Some of them, belonging to the Central American forms, were figured by Waterhouse.[16] The combs are in most cases the only reliable characters on which to divide some forms, which are often extremely similar to each other. It is peculiar that the two forms sent to me resemble more the neotropical species than they do *P. wallacei* H. Deyrolle.

Pachyschelus orientalis sp. nov. Plate 1, fig. 10.

Speciei *singaporensis* sp. nov. simillimus ac solum ita diffinis:

Corpore supra minus nitido, elytris coeruleis, thorace nigro, lateribus leviter aeneis, corpore subtus nigroaeneo. Elytris minus latis, plus ovalibus, thorace lateribus minus rotundatis, angulis posticis minus prominulis. Capite aurato. Elytris distinctius punctato striatis, paulo magis convexis, impressione laterali minori; fronte multo latiore ac breviore. Segmento anali medio fortiter impresso, lateribus impressionibus obliquis marginatis.

[16] Biologia Centrali-Americana.

Patria: Singapore (*Baker*). Long. 2.5 mm. Lat. 1.8 mm.

This species is very similar to *P. singaporensis* sp. nov. It differs only in being smaller and narrower; in the wider and shorter front; the smaller lateral impression of the elytra; and the more distinctly indicated serial puncturation on the elytra.

Head golden, prothorax black with slightly bronzed sides, elytra blue, less shining than in *P. singaporensis*. Last ventral segment (male and female) with a deep median impression and with linear oblique impressions on each side.

Pachyschelus singaporensis sp. nov. Plate 1, fig. 9.

Latus, latitudinem maximam in medio corporis attingens. Supra cyaneus, nitidus, glabratus; capite satis lato, medio leviter impresso, antice aurato, glabro. Poris frontalibus lateralibus impressione transversa acuta lineari conjunctis ac epistomate ita separato. Prothorace longitudine fere 4 latiori, lateribus fortiter rotundatis, angulis posticis acutis; scutello lato, magno. Elytris post humeris latissimis, ad anticem fortiter (in una linea cum thorace) rotundatis, ad apicem satis longe rotundatim attenuatis, apicibus paullo oblique rotundatis; posthumeris lateribus impressis. Superficie glabra, nitida, punctis nonnullis subseriatim dispositis, fere indistinctis. Corpore subtus pedibusque nigris, nitidis. Segmento anali lateribus ac medio impresso. ♂ segmento anali apice pectina minuto octodentato, dentis his in medio angulo maiori formi $\wedge$ in partes duo divisis.

Patria: Singapore (*Baker*). Long. 3 mm. Lat. 2.2 mm.

Blue, shining; undersurface black, shining. Hairless; very wide; the greatest width in the middle of length. Head anteriorly golden, rather wide, with a distinct median impression in the middle. Prothorax very wide, shining, with some punctures laterally; sides very strongly rounded, with acute posterior angles. Elytra wide, rather convex, with a lateral impression on each side behind humeri, with some traces of fine longitudinal puncturation. Undersurface shining, the anal segment impressed in middle and on sides. Last ventral segment of male adorned on apex with a little comb of eight teeth (See Plate 1, fig. 9), which is divided in the middle by a deeper median incision.

The present species resembles very much some Brazilian forms. Also, the anal markings of the male are similar to those of American forms. I have seen only one specimen of this peculiar species; the type is in the Baker collection, numbered 12625.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Aphanisticus corniceps* sp. nov.
2. *Aphanisticus perakensis* sp. nov.
3. *Aphanisticus peninsulae* sp. nov.
4. *Aphanisticus bakeri* Fisher.
5. *Aphanisticus dapitani* sp. nov.
6. *Aphanisticus sandakanus* sp. nov.
7. *Aphanisticus bohaci* sp. nov.
8. *Paratrachys bakeri* sp. nov.; *a*, head, showing episternal emargination, *e*.
9. *Pachyschelus singaporensis* sp. nov.; *a*, head, showing epistomal emargination, *e*; *b*, anal comb of male.
10. *Pachyschelus orientalis* sp. nov.; *a*, head, showing epistomal emargination, *e*.
11. *Endelus belial* sp. nov.
12. *Endelus aphanisticinus* sp. nov.
13. *Endelus bakerianus* sp. nov.
14. *Endelus borneensis* sp. nov.
15. *Meliboeus pravus* sp. nov.
16. *Meliboeus carbonicolor* sp. nov.
17. *Meliboeus dapitanus* sp. nov.
18. *Sambus sandakanus* sp. nov.
19. *Sambus bakerianus* sp. nov.
20. *Sambus maquilingi* sp. nov.
21. *Sambus delicatulus* sp. nov.
22. *Sambus adonis* sp. nov.
23. *Sambus faustinus* sp. nov.
24. *Sambus philippinarum* sp. nov.
25. *Trachys cupripyga* H. Deyrolle; *a*, prosternal process.
26. *Trachys isolata* sp. nov.; *a*, prosternal process.
27. *Trachys subaeneella* sp. nov.; *a*, prosternal process.
28. *Trachys scriptella* sp. nov.; *a*, prosternal process.
29. *Trachys dapitana* sp. nov.; *a*, prosternal process.
30. *Trachys fisheri* sp. nov.; *a*, prosternal process.
31. *Trachys picta* Fisher; *a*, prosternal process.
32. *Trachys eschscholtzi* sp. nov.; *a*, prosternal process.

PLATE 2

FIG. 1. *Agrilus exclusus* sp. nov.
2. *Agrilus cannulus* sp. nov.
3. *Agrilus albocinctus* Fisher.
4. *Agrilus harlequin* sp. nov.
5. *Agrilus spinellifer* sp. nov.

6. *Agrilus perniciosellus* sp. nov.
7. *Agrilus oneratus* sp. nov.
8. *Agrilus luctuosellus* sp. nov.
9. *Agrilus intrusus* sp. nov.
10. *Agrilus pilistoma* sp. nov.
11. *Agrilus agrestis* H. Deyrolle.
12. *Agrilus nigrocinctus* E. Saunders.
13. *Agrilus insularis* H. Deyrolle.
14. *Agrilus inconstans* Fisher.
15. *Agrilus albogaster* H. Deyrolle.
16. *Agrilus inquinatus* E. Saunders.
17. *Agrilus fisheri* nom. nov.
18. *Agrilus subvittatus* Fisher.
19. *Agrilus atratulus* sp. nov.
20. *Agrilus croceisquamis* sp. nov.
21. *Agrilus manilensis* Fisher.
22. *Agrilus viridicolor* sp. nov.
23. *Agrilus encaustus* sp. nov.
24. *Agrilus zamboangensis* Fisher.
25. *Agrilus subpubescens* Fisher.
26. *Agrilus aureocoerulans* sp. nov.
27. *Agrilus pterochlorus* sp. nov.
28. *Agrilus orientis* sp. nov.
29. *Agrilus operosus* sp. nov.
30. *Agrilus saundersianus* sp. nov.
31. *Agrilus tardulus* sp. nov.
32. *Agrilus ludificator* sp. nov.
33. *Agrilus pictithorax* sp. nov.
34. *Agrilus simillipictus* sp. nov.
35. *Agrilus carinellifer* sp. nov.
36. *Agrilus optatus* sp. nov.
37. *Agrilus sandakanus* sp. nov.
38. *Agrilus xenius* sp. nov.
39. *Agrilus dajakorum* sp. nov.; *a*, processes of the carina of last ventral segment.
40. *Agrilus purpurifrons* H. Deyrolle.

PLATE 3

FIG. 1. *Agrilus singaporensis* sp. nov.
2. *Agrilus falsulus* sp. nov.
3. *Agrilus tristinus* sp. nov.
4. *Agrilus pilipennis* sp. nov.
5. *Agrilus uniformipubis* sp. nov.
6. *Agrilus lazar* sp. nov.
7. *Agrilus carinipennis* sp. nov.
8. *Agrilus bidentellus* sp. nov.
9. *Agrilus oppositus* sp. nov.
10. *Agrilus perniciosus* H. Deyrolle.
11. *Agrilus persolitarius* sp. nov.
12. *Agrilus microtatus* sp. nov.
13. *Agrilus kheili* sp. nov.

14. *Agrilus piperi* Fisher.
15. *Agrilus acutus* Thunberg.
16. *Agrilus pterochlorus* sp. nov.; *oc*, oculi, the eyes; *o*, the mouth; *gl*, lobus gularis, prosternal lobe; *sm*, submarginal carina; *m*, marginal carina; *ph*, prehumeral carina; *ch*, lateral, cariniform margin of the humeri; *ce*, humeral carina of the elytra; *c*, hind coxa.
17. *Agrilus exclusus* sp. nov.; *ph*, prehumeral carina; *m*, marginal carina; *sm*, submarginal carina; *oc*, the eye; *ce*, elytral carina; *ep*, epipleura. Figures 17 to 44 indicate the positions of the thoracic carinæ in various species of the genus *Agrilus;* the names and relative positions of the carinæ are indicated by letters in fig. 17. The series of figures is continued on Plate 4, figs. 1 to 26.
18. *Agrilus cannulus* sp. nov.
19. *Agrilus albocinctus* Fisher.
20. *Agrilus harlequin* sp. nov.
21. *Agrilus spinellifer* sp. nov.
22. *Agrilus perniciosellus* sp. nov.
23. *Agrilus oneratus* sp. nov.
24. *Agrilus luctuosellus* sp. nov.
25. *Agrilus intrusus* sp. nov.
26. *Agrilus pilistoma* sp. nov.
27. *Agrilus agrestis* H. Deyrolle.
28. *Agrilus nigrocinctus* E. Saunders.
29. *Agrilus inconstans* Fisher.
30. *Agrilus insularis* H. Deyrolle.
31. *Agrilus albogaster* H. Deyrolle.
32. *Agrilus inquinatus* E. Saunders.
33. *Agrilus fisheri* nom. nov. (=|| *fulvovittatus* Fisher).
34. *Agrilus subvittatus* Fisher.
35. *Agrilus kheili* sp. nov.
36. *Agrilus piperi* Fisher.
37. *Agrilus acutus* Thunberg.
38. *Agrilus sandakanus* sp. nov.
39. *Agrilus xenius* sp. nov.
40. *Agrilus dajakorum* sp. nov.
41. *Agrilus purpurifrons* H. Deyrolle.
42. *Agrilus singaporensis* sp. nov.
43. *Agrilus falsulus* sp. nov.
44. *Agrilus tristinus* sp. nov.

PLATE 4

FIG. 1. *Agrilus pilipennis* sp. nov.; *ph*, prehumeral carina; *m*, marginal carina; *sm*, submarginal carina; *oc*, eye; *ce*, elytral carina; *ep*, epipleura; *u*, claw. Figures 1 to 26 indicate the positions of the thoracic carinæ in various species of the genus *Agrilus*, a continuation from Plate 3; the names and relative positions of the carinæ are indicated in figs. 8 to 11.

2. *Agrilus uniformipubis* sp. nov.
3. *Agrilus perniciosus* H. Deyrolle.

4. *Agrilus persolitarius* sp. nov.
5. *Agrilus microtatus* sp. nov.
6. *Agrilus oppositus* sp. nov.
7. *Agrilus bidentellus* sp. nov.
8. *Agrilus atratulus* sp. nov.
9. *Agrilus croceisquamis* sp. nov.
10. *Agrilus manilensis* Fisher.
11. *Agrilus carinipennis* sp. nov.
12. *Agrilus lazar* sp. nov.
13. *Agrilus viridicolor* sp. nov.
14. *Agrilus encaustus* sp. nov.
15. *Agrilus zamboangensis* Fisher.
16. *Agrilus subpubescens* Fisher.
17. *Agrilus aureocoerulans* sp. nov.
18. *Agrilus orientis* sp. nov.
19. *Agrilus operosus* sp. nov.
20. *Agrilus saundersianus* sp. nov.
21. *Agrilus tardulus* sp. nov.
22. *Agrilus ludificator* sp. nov.
23. *Agrilus pictithorax* sp. nov.
24. *Agrilus simillipictus* sp. nov.
25. *Agrilus carinellifer* sp. nov.
26. *Agrilus optatus* sp. nov.
27. *Trachys speciosella* sp. nov., head; *e*, epistome; *l*, lateral pores; *a*, antennal grooves; *m*, middle pori.
28. *Trachys dajakorum* sp. nov., head; *e*, epistome; *l*, lateral pores; *a*, antennal grooves; *m*, middle pores; *g*, gular processes.
29. *Trachys dajakorum* sp. nov.
30. *Trachys philippinensis* Fisher.
31. *Trachys sandakana* sp. nov.
32. *Trachys conscripta* sp. nov.
33. *Trachys speciosella* sp. nov.
34. *Trachys uniformata* sp. nov.
35. *Trachys singaporensis* sp. nov.
36. *Trachys bakeriana* sp. nov.
37. *Trachys saundersiana* sp. nov.
38. *Trachys praora* sp. nov.
39. *Trachys miana* sp. nov.

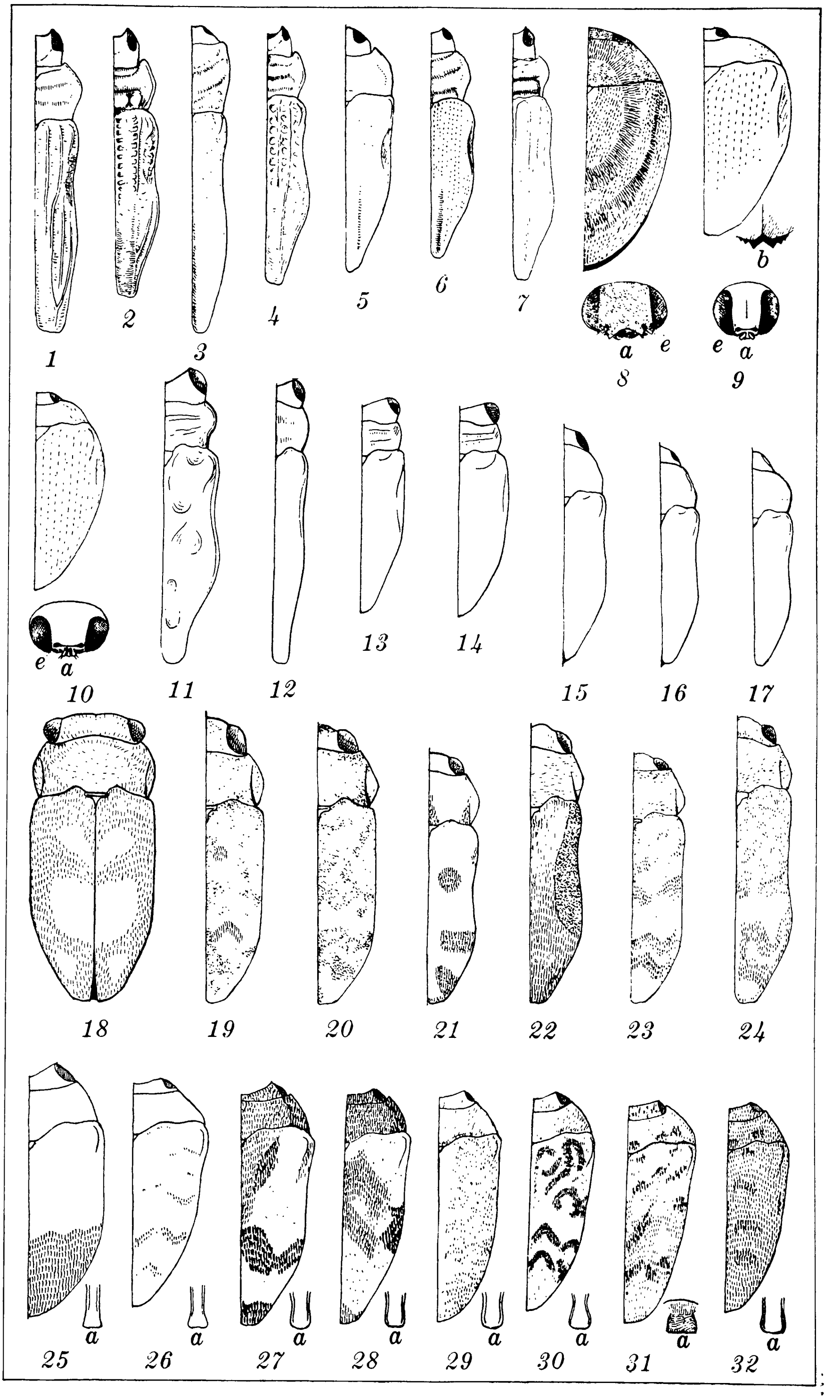

1
2
3
4
5
6
7
a e
8
b
e a
9
e a
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
a
25
a
26
a
27
a
28
a
29
a
30
a
31
a
32

PLATE 1.

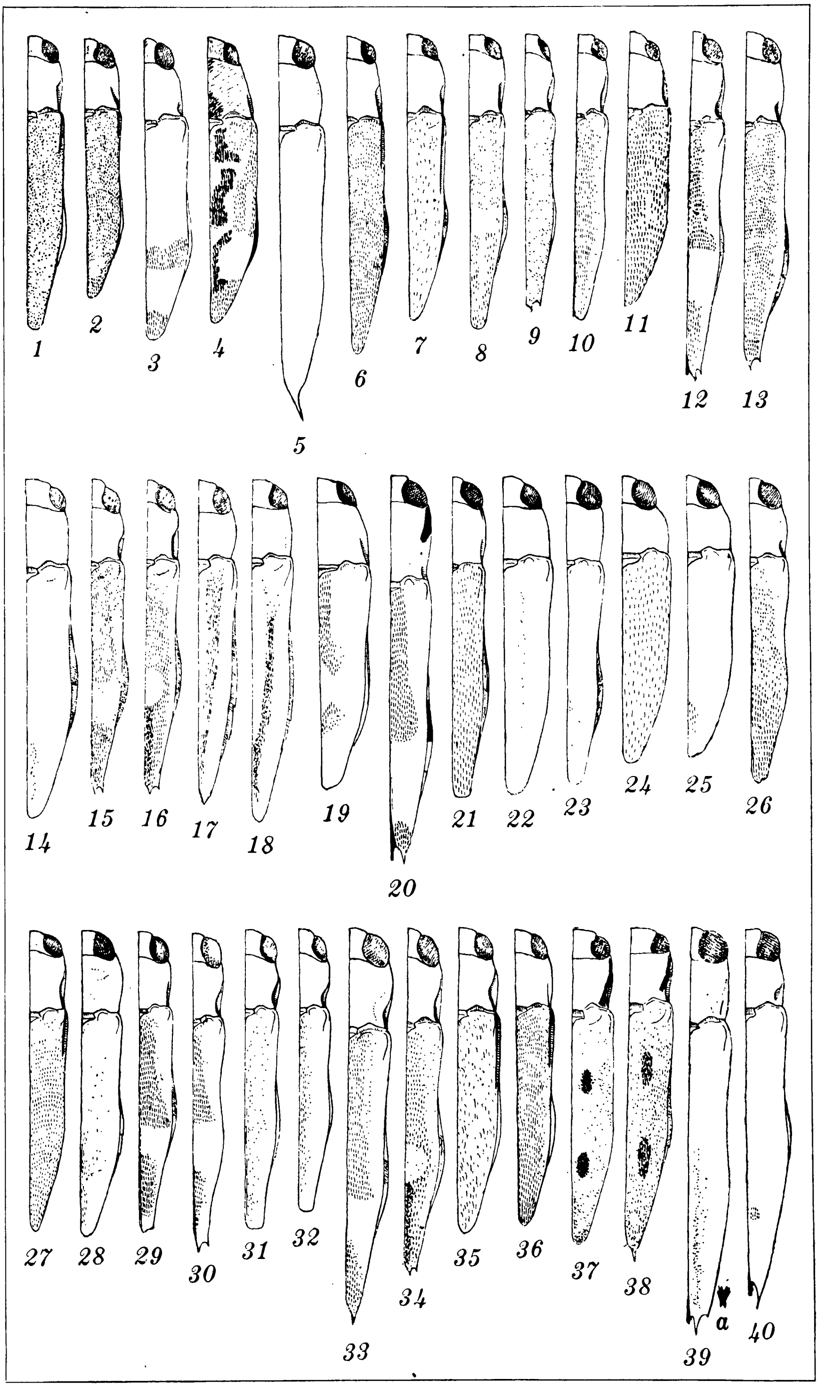

1 2 3 4 5 6 7 8 9 10 11 12 13
14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 a 40

PLATE 2.

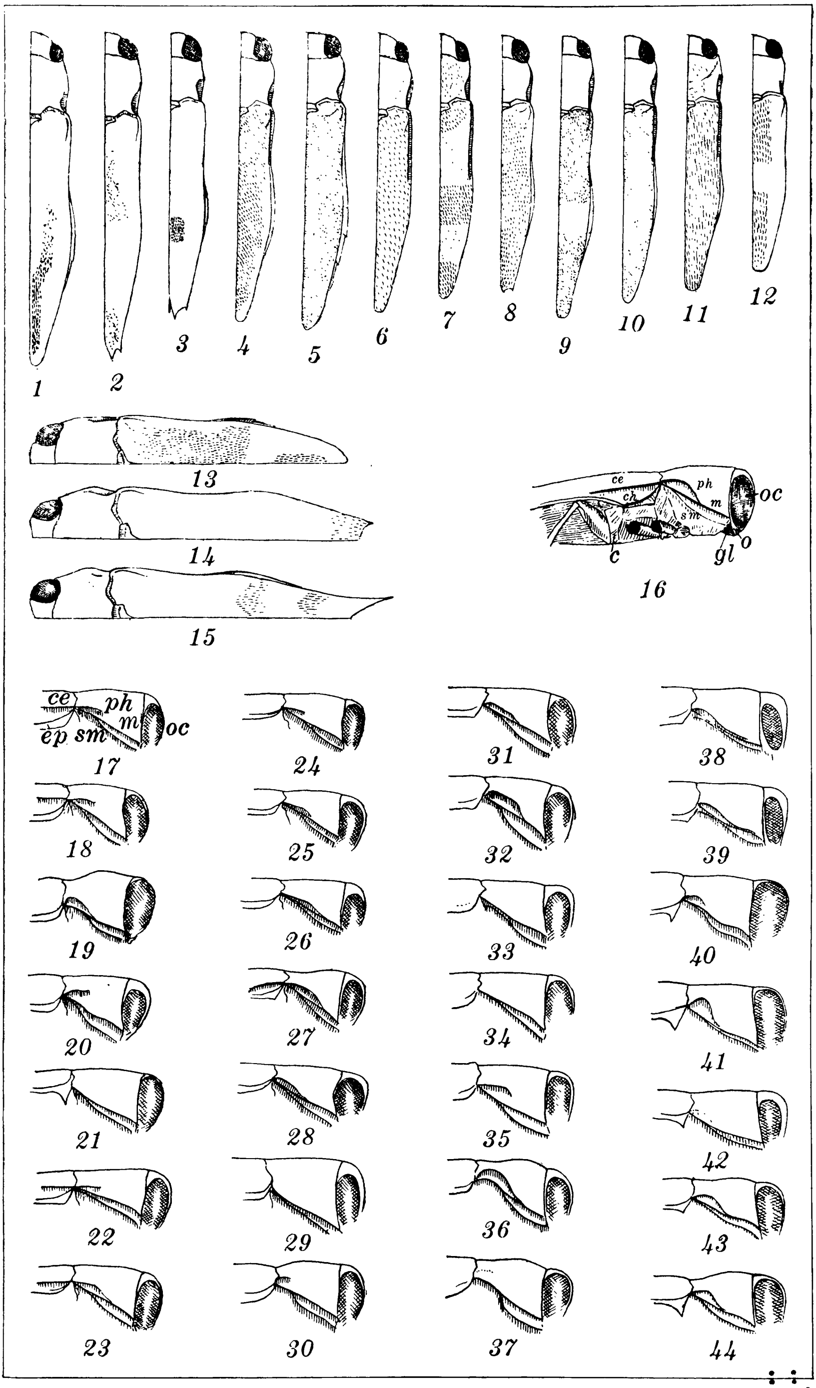

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
ce
ch
ph
m
oc
sm
c
gl
o
16
ce
ph
m
ep
sm
oc
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44

PLATE 3.

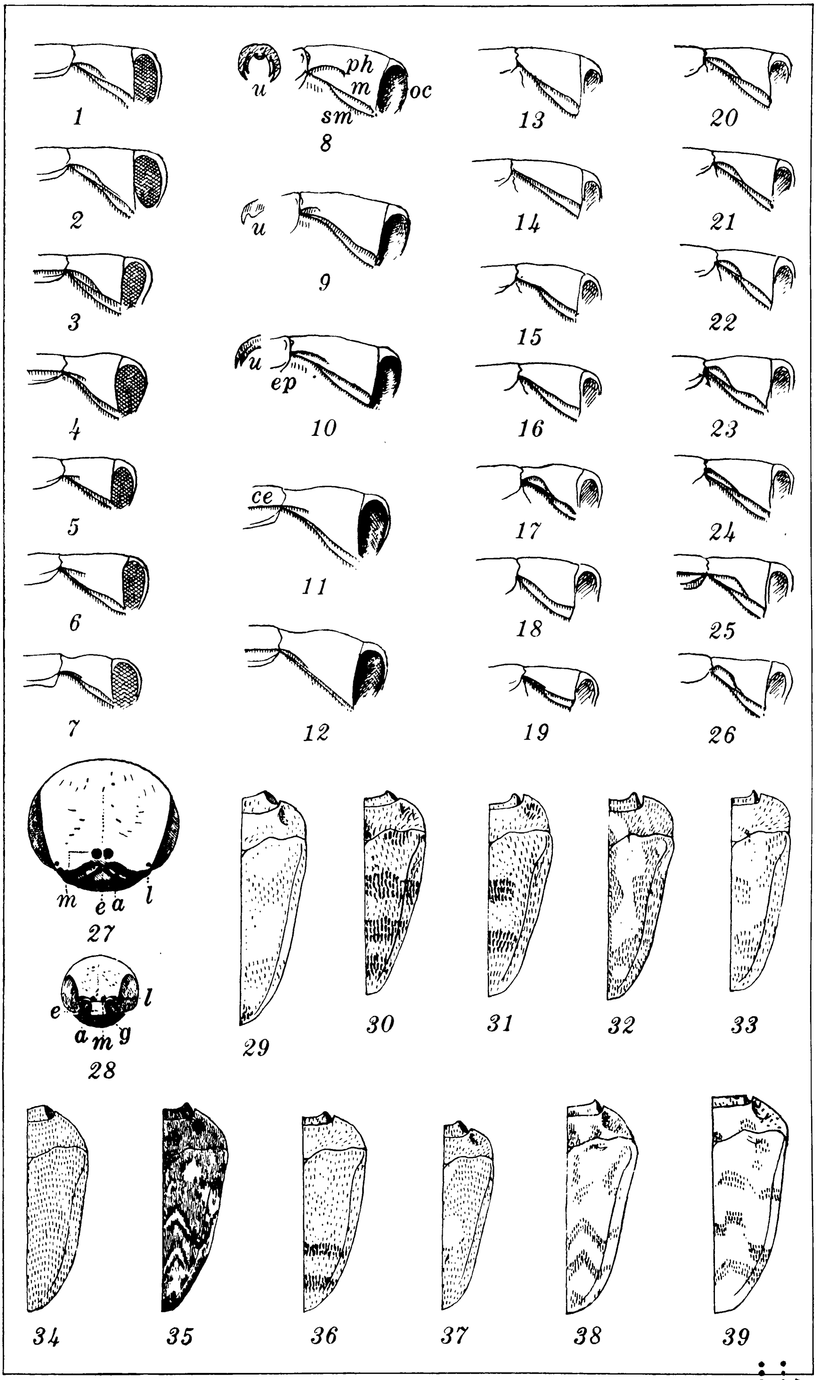

1
2
3
4
5
6
7
u
ph
m
oc
sm
8
u
9
u
ep
10
ce
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
m
e
a
l
27
e
l
a
m
g
28
29
30
31
32
33
34
35
36
37
38
39

PLATE 4.

VOL. 25, NO. 6 DECEMBER, 1924

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1924

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science of the Government of the Philippine Islands

Manuscript intended for publication should be sent to the editor. One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Library, Bureau of Science, Manila, P. I.

The Journal is issued twelve times a year. The subscription price is 5 dollars, United States currency, per year. Single numbers, 50 cents each.

Subscriptions may be sent to the BUSINESS MANAGER, Philippine Journal of Science, Bureau of Science, Manila, P. I., or to any of the agents listed on the third page of this cover.

THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. 25 DECEMBER, 1924 No. 6

COMPLAINTS OF PATIENTS UNDER ANTILEPROSY TREATMENT, I

NATURE AND FREQUENCY IN CASES RECEIVING CHAULMOOGRA ETHYL ESTER PREPARATIONS [1]

By H. W. WADE, C. B. LARA, and C. NICOLAS

Chief Pathologist, Chief Physician, and Supervising Physician of Clinic I, Culion Leper Colony, Philippine Health Service

TOPICAL SUMMARY

[1] This paper is based on work done by the treatment staff while the senior author was serving temporarily as acting chief physician and, as such, chairman of the staff committee controlling the treatment work, and while the present chief physician was supervising physician of Clinic II. The material used is from reports from the clinic records of Drs. J. M. Alonso, G. Fernandez, G. Limkako, E. Roxas-Pineda, J. Samson, F. Tuason, F. Velasco, and B. de Vera, to whom due acknowledgment is hereby made. Published with the consent of the Director of Health and the approval of the Philippine Leprosy Research Board.

GENERAL INTRODUCTION

In all considerations of a disease and its treatment there are many apparently minor features that, individually or in summation, are of importance for the definition of the problems that are presented. In the present state of knowledge of most diseases it is no longer acceptable to deal loosely with their major features, the landmarks, as it were; precise knowledge of their minor elements is required, and these have been or are being studied intensively and exhaustively. In leprosy, unfortunately, comparatively few studies of this sort have been made. Though the problem is large and difficult, and has long been studied, many major features are not yet well defined. The workers are comparatively few, and often they are so handicapped in the way of time, equipment, and material that comparatively little opportunity is had for really intensive work. Therefore, much of the literature, which is not accumulating with any great rapidity, necessarily does not deal with the subject in the light of precise knowledge. This is our reason, and apology if such be necessary, for presenting in considerable detail data much of which may seem—and indeed very likely is—of decidedly minor importance.

In the course of the work of the treatment staff of the Culion Leper Colony it was found desirable to establish definitely the relative values of certain preparations of the chaulmoogra ethyl esters used as the basic medication. For this it was preferred not to depend upon a determination of the apparent effects in the matter of improvement in patients after a sufficient period of trial, but also to study the more immediate side-effects, as these are often important, particularly in certain classes of cases.

It seems now to be recognized by leprologists that distinction must be made between two main types of patient groups. One is composed chiefly of early cases, with respect either to duration or to advancement. Such are more frequently met with in institutions of first segregation like the Kalihi Leper Hospital in Honolulu and the San Lazaro Hospital in Manila, both of which are primarily collecting stations, though antileprosy treatment is given to all cases admitted to them. The other group is composed of cases of the later degrees of duration and advancement, which greatly predominate in the more usual leprosarium.

In actual treatment work these two groups present distinctly different problems. Practical experience indicates that the more recent cases can, as a rule, be given more-intensive treatment with less apparent injury from the treatment itself and, certainly, with much better ultimate effect on the disease. For this reason it cannot be expected that the results of treatment in the general leprosarium will be directly comparable with those obtained in the segregation asylum. It is necessary in such institutions, if experience in this colony is any criterion, to place much importance on the conditions that tend to limit the intensiveness of treatment, which makes it essential to use a preparation that produces as few of these as possible.

Reports on the more modern leprosy treatments do not always discuss the various side-effects seen in cases under treatment, and none of which we have knowledge deals with them in detail. Since most leprosaria are, at least in effect, institutions of final segregation, with a majority of cases in which these side-effects are important, it is deemed desirable to publish in some detail data on certain observations made here.

DATA PRESENTED

The necessity of individualizing cases under treatment is generally recognized. It is not sufficient for an efficient treatment campaign to install a group of semitrained injectors, such as

nurses, under the supervision of a comparatively few physicians. It was this consideration that led the Philippine Health Service, when in 1922 it was decided to extend modern treatment to the great bulk of the five thousand and more inmates of this colony, to install a medical and nursing staff that to some seemed unnecessarily large and expensive, though actually it was still inadequate, since it was necessary to assign about four hundred fifty cases to each treating physician. In spite of the considerable amount of clerical work involved, ever since the work was begun on a small scale in 1921 the treating physicians have been expected regularly to record, besides the treatments given, the incidents and complaints reported by or observed in the patients treated. These records are, obviously, of value in determining the immediate and incidental effects of the various preparations used, and furnish the material on which the present series of reports is based.

Previous to April, 1923, all but a relatively few of the cases under treatment were receiving either plain chaulmoogra ethyl esters or a preparation containing 2 per cent iodine. The impression having become current that the iodine itself was responsible for some of the side-effects seen, the staff committee deemed it desirable to determine whether a 0.5 per cent iodized preparation would be preferable. Eight of the treating physicians were thereupon requested to divide their groups receiving the iodized drug into two approximately equal subgroups, for comparison of these two preparations. They were informed that reports would be required on the side-effects observed in these groups, and somewhat over two months later detailed reports were obtained for the period from April 15 to June 15; for comparison similar reports were obtained on the plain-drug groups for the same period. In the present paper the data are examined from a general viewpoint; the comparisons of the three preparations will be made in a second paper. A third paper is based on a similar comparison of creosoted and noncreosoted ethyl esters, made later in the year. A fourth paper is contemplated on the chaulmoogra-olive-camphor mixture known in the Philippines as the Mercado formula, which was developed under Heiser's administration as Director of Health and was popularized by him; it has been found desirable to compare the effects of this preparation, as now made with comparatively nonirritating chaulmoogra oil, with those of the ethyl esters.

The staff was not forewarned that a report would be made on the group receiving the plain ethyl esters and this may lessen the accuracy of the comparison, for it is possible that some of the physicians may have paid more attention to recording the incidents of the cases known to be under special observation. On the other hand, this would have made no difference with conscientious workers; further, the fact that special attention was being paid this matter in certain groups may have stimulated attention to it in the others.

Most conditions actually demanding the attention of the physicians, either directly or through complaints of the patients—as, for example, choking, severe local inflammation, and lepra reactions—were undoubtedly recorded, whatever drug was used. For the other incidents the physicians must depend largely on the testimony of the patients at the time of their next visit, usually at least one week later and oftentimes, due to failure of patients to report to the clinic, after two weeks or more. The more unpleasant occurrences are, on the whole, regularly reported by the patients, who regard them with some degree of apprehension and report them so as to be excused from the next injection. They usually are excused, for it is deemed not justifiable to require patients to take the injections unwillingly. Of course, this leads to another source of error, for some undoubtedly report fictitious complaints; but it is felt that, in the main, they desire to be treated and that when they object to injections they usually have cause to do so.

From a careful consideration of the data we are inclined to believe that these possible sources of error have not caused any essential inaccuracy, and that, while the figures obtained for some of the items are undoubtedly too low, most of the total figures afford valid information at least regarding the relative frequency of the various incidents. They are undoubtedly much more accurate for comparison of the different preparations in this respect, as the personal equation of any individual physician may be expected to affect the records of all of his patients similarly.

NUMBER OF CASES TREATED AND COMPLAINING

The total numbers of cases treated in the groups under consideration, their distribution in the two clinics, and the numbers and percentages of these for whom one or more complaints were registered during the two months involved, are given in Table 1. It is to be noticed that here, as in most tables in

this report, percentages are reduced to the nearest whole number when they are 10 or over. This facilitates comparisons and is considered preferable in such studies as this where mathematical accuracy in the work on which the data are based is not attained. Because of this practice the totals frequently show an error of one.

TABLE 1.—*Numbers and distribution in clinics of patients treated and complaining.*

Clinic unit.	Cases treated.		Cases complaining.	
	Number.	*Per cent.*	*Number.*	*Per cent.*
I, 1	392	13.9	268	68
I, 2	360	12.8	226	63
I, 3	375	13.3	200	53
I, 4	382	13.6	260	68
Total, Clinic I	1,509	53.6	954	63
II, 1	291	10.3	248	85
II, 2	365	12.9	327	90
II, 3	355	12.6	274	77
II, 4	298	10.6	182	61
Total, Clinic II	1,309	46.4	1,031	79
Grand total	2,818	100.0	1,985	70

Numbers treated.—The total number of cases registered in the treatment groups included in this report is 2,818, certainly a sufficiently large number to make a statistical treatment of the data of value. Somewhat more than one-half (53.6 per cent) were registered in Clinic I. The numbers per clinic unit range from 291 to 382 (10.6 to 13.9 per cent of the whole), with an average of 352.

Numbers complaining.—During the two months involved records were made of one or more complaints for each of 1,985 cases, 70.5 per cent of the whole. Clinic I reported much fewer complaining than did Clinic II, 63 per cent as compared with 79 per cent.

CLINIC DIFFERENCES

The differences between the clinics are typical of those seen throughout these analyses. Besides individual variations between units of each clinic, the clinic totals differ widely. Clinic I has almost always decidedly lower figures than Clinic II. This is probably in large part due to differences in the patients treated. Those of Clinic I have on the average been under

treatment longer, a total of 1,525 patients having been registered there at the time Clinic II started, in April, 1922. They include those of the selected group of 500 first treated in July, 1921, that remained under treatment. Clinic II, on the other hand, has few selected cases; the great majority taken on there were advanced, and many had incipient complications which tend to increase the complaint rate. However, there is some evidence that the typical clinic differences do not depend wholly on this factor. In the third paper the same differences will be seen in the groups of recent duration, recently brought to Culion, as in the older cases. Furthermore, as will be seen there, the elimination of several hundred unsuitable cases from Clinic II did not reduce the clinic differences. Therefore, it would seem that, as the personal equation affects the records of the individuals of a clinic group, an analogous "group equation" affects those of the two clinics. For this reason, the clinic figures will frequently be considered separately.

NATURE OF COMPLAINTS

The complaints and incidents registered may be classified, with very few exceptions, into five types, though a sixth should be determined, as will be pointed out.

TYPE 1, IMMEDIATE EFFECTS

Immediate effects are choking and dizziness. These occur during or immediately after the injection, and practically invariably occur in the clinic room. In the first of these reactions the patient is suddenly attacked with a paroxysm of choking with violent coughing. The face becomes markedly flushed, respiration is difficult, and active perspiration often occurs. Dizziness may occur in these paroxysms, but it is overshadowed by the other symptoms. A strong taste of the chaulmoogra oil is often complained of, and the odor may sometimes be noted on the breath. The attack lasts but a few minutes. The patient often complains afterwards of chest pain which lasts for a day or two, seldom for a week, though rarely it may persist for a month or even more.

Dizziness is more frequently observed alone than as an accompaniment of choking. This is usually not alarming and quickly passes off, with no sequela except perhaps headache. More severe attacks are accompanied by dimness or even temporary loss of vision; very rarely localized twitchings or general muscular convulsions have been observed.

Patients often complain seriously of these occurrences, but so far there has been not a single death directly or indirectly attributable to them. The obvious explanation of them is that during injection the needle point is within a venous channel in the muscle mass and that the injection is therefore actually given intravenously. It will be noted that these events were recorded much more frequently by certain of the physicians than by the others. The explanation is not apparent. It is possible that it lies in differences in technic; some may have injected deeply and others superficially, or some may possibly have regularly tested for blood at the needle-tip by traction on the piston and others may not have done so.

It may be remarked that a few patients are said by their physicians—and this is suggested by the figures—to be peculiarly liable to these phenomena. No explanation for this is suggested unless it be that their venous channels are unusually large or relatively numerous.

TYPE 2, LOCAL EFFECTS

Local effects are recorded as induration, abscess, and pain. Some degree of local reaction to the injected material is, undoubtedly, a constant occurrence; it is the degree and persistence of this that is of significance. Troublesome local reactions are important because, if frequently repeated, they tend to discourage the patient, which makes it very desirable to determine the least irritating effective preparation.

The only condition of importance is simple inflammation, with swelling and more or less pain. Ordinarily, the local reaction is moderate and lasts but a few days, and it may not be especially noticed, particularly by patients who have been treated for some time; they may report no trouble, though on inspection more or less residual induration may often be found. The necessity of examining the site of the last injection to determine such an induration, and the fact that the patients line up for injection with the site, usually selected by themselves, prepared for the injection, seems to limit the recording of this condition to instances severe enough to cause the patient voluntarily to complain.

The frequency of troublesome reactions may, to some extent, be determined by the technic of injection. Certainly, if any of the drug is placed subcutaneously there is much more likelihood of trouble than if it is all put deep into the muscle. Though this reaction usually occurs at the site of injection, sometimes

it is found at some distance (10 to 20 centimeters) below, evidently because of gravitation of the drug. Frequently the nearest lymph nodes are found to enlarge, and occasionally troublesome adenitis develops, which in a number of instances has gone on to necrosis and ulceration, very slow in healing.

Abscess formation, a distinctly infrequent event, is an occurrence that is not entirely preventable. The abscesses are usually sterile, due to drug necrosis.[2] On what condition their development depends is not known. Only rarely does a case show a special tendency to this accident.

Pain at the injection site was recorded specially by only two or three physicians, in such small numbers that a separate classification is not justified; they are, therefore, included in the "induration" figures. Exquisite lancinating pain, deep and distinct from that occasioned by the skin puncture, is sometimes complained of during the injection. This is probably the result of injection directly into a nerve. It is very infrequent when the injection is in the arm or the buttock, usually occurring in the forearm or leg, where patients sometimes insist that the injection be given.

TYPE 3, GENERAL SYMPTOMS

Here are grouped headache, malaise, weakness (usually not differentiated from malaise), simple fever, chill or chilliness, insomnia, anorexia, and abdominal pain. The figures for the last have, in the compilations, erroneously been included in Type 5, but the number reported was so small that the results are not affected. Another complaint sometimes made is a peculiar sensation of general heat, but this was not recorded in these reports.

Of this symptom-group it is obviously impossible always to determine in a given instance to what the trouble may be due. In inmates of a leper colony, many of whom have ulcers that may be more or less infected, tuberculosis, or early nephritis superimposed on the basic disease, such occurrences would not be infrequent without treatment. However, there is no doubt in our minds that the treatment increases their frequency, and

[2] The following data on bacteriological examinations of material from abscesses has been furnished by Dr. F. Solis, assistant pathologist in charge of bacteriological routine: Specimens submitted, 1923, 60. Sterile (smears and cultures) 36; acid-fast bacilli (*B. lepræ*) in smears, 3; culturally positive, 21. Organisms isolated: *Staphylococcus aureus*, 18; *Streptococcus* (hæmolytic), 2; Gram negative bacillus, 1.

as they are often reported by patients as reasons for not receiving injections they decidedly affect the treatment work.

TYPE 4, RESPIRATORY TRACT SYMPTOMS

Chest pain and chest oppression, with or without cough, and cough alone, are frequent complaints. They are very important here in as much as a large percentage of the inmates present evidence of latent or active tuberculosis, and the ethyl esters, if injudiciously used, seem clearly to activate this condition. The patients are perhaps more apprehensive of this than of any other side-effect of the treatment, and seem faithfully to report these events when they occur—and, perhaps, sometimes when they do not.

TYPE 5, LEPRA REACTION SYMPTOMS

Lepra fever and cutaneous eruptions without fever are the two principal occurrences in this group recorded by the staff. Other complaints here grouped are neuritis, rheumatic pain, orchitis, and inflammatory reaction of the eye, these usually when occurring in the absence of general lepra reaction symptoms. Arthritic reaction is also occasionally seen, but it was not recorded in these reports. The nature and relationship of these conditions cannot be discussed here; they are being paid particular attention and will probably be reported on separately. Suffice it to say that the minor incidents mentioned, arising abruptly and subsiding more or less slowly, are believed usually to be of the nature of localized "reactions." Eye inflammation is of special interest, as the impression had been gained that the iodized preparation is particularly prone to cause it. It is usually in the form of iritis, and iridocyclitis in severe cases, with intense pain. Rarely is there suppurative inflammation. This complaint may be a part of the manifestation of a general lepra reaction. Ordinarily it lasts from a few days to one or two weeks; a few cases last several months.

Lepra reactions are generally recognized to be of special interest in treatment work. Repeatedly it is seen that after the subsidence of a reaction old lesions tend to improve; consequently, some authors consider it desirable to cause such reactions. As has been said elsewhere [3] it seems from our statistics that on the whole they are not beneficial, though this probably refers to the more severe types. Whether the ideal

[3] Wade, H. W., Journ. Phil. Is. Med. Assoc. 3 (1923) 236–241.

drug should produce few reactions, or frequent mild ones, we believe is yet to be established.

TYPE 6 (PROPOSED), NEPHRITIS

This condition and the symptoms arising from it should constitute a sixth group of incidents and side-effects. Obviously, it would be most difficult to separate from group 3 the complaints having kidney disturbance as the underlying cause. Usually when œdema occurs that is differentiable from the swellings common in lepers the patient has to be hospitalized. Since frequent routine urinalyses are not carried out on all cases under treatment, nephritis has no place in the data to be presented. However, it is one of the most important complications of the treatment work here, perhaps not second even to tuberculosis. Though the death rate in this colony has not increased since the treatment work began (it was 9.4 per cent in 1922 and 9.1 per cent in 1923), and though the proportion of deaths from tuberculosis has not increased significantly, if at all, the deaths due to chronic nephritis increased markedly in 1923 over the 1922 figure. A recent survey of over eight hundred unselected cases under treatment revealed a very large proportion with some degree of albumen and with casts. This matter is now being paid particular attention.

FREQUENCY OF COMPLAINTS

In a consideration of frequency of complaints there are two main features; namely, the number of patients of a group who complained, as indicated by percentages, and the number of complaints recorded. For the latter either of two frequency rates is used here. One is based on the total number of patients in the entire group for which the rate is given, the other on the number of patients of that group for whom any complaint was reported. To avoid possible confusion, the former is here referred to as the "total" complaint rate, and is given as per 100 cases treated; this may be of nearly any value, ranging, as in Table 4 for example, from 4.1 to 225. The latter is called the "excess" complaint rate and is so given as to show the average number of complaints recorded in excess of one for each patient complaining; they are therefore usually fractions, as in Table 3, where they range from 0 to 0.67. The latter figure does not indicate that 67 patients per hundred registered two complaints; there may, for example, have been 60 patients complaining, seven of these with three complaints.

TABLE 2.—*Percentages of patients complaining of various symptoms and incidents.*

Symptom or incident.	Clinic I.			Clinic II.			Total average.
	Low unit.	High unit.	Average.	Low unit.	High unit.	Average.	
Choking	2.0	7.2	2.9	2.4	10.4	7.1	4.9
Dizziness	1.3	2.6	2.0	0	2.4	1.0	1.5
Induration	12.8	39.5	20.3	9.9	42.7	22.4	21.3
Headache	2.4	11.1	5.2	2.0	10.1	6.9	6.0
Malaise and weakness	2.0	4.7	3.4	3.0	17.2	9.9	6.4
Fever (simple)	2.8	11.0	7.4	7.3	17.1	11.5	9.3
Chest oppression and chest pain	6.5	12.2	9.9	13.8	32.0	20.7	15.0
Cough (only)	4.4	28.6	15.6	9.4	34.6	23.0	19.1
Cutaneous reaction and lepra fever	13.0	18.9	15.6	11.6	16.0	12.8	14.3
Eye inflammation	1.1	3.6	2.3	2.1	3.3	2.9	2.6
Rheumatic pain	0.8	3.1	1.9	0.3	3.9	1.8	1.8

FREQUENCY OF INDIVIDUAL SYMPTOMS

The frequency of the more important individual complaints will be considered here separately; in subsequent sections they will be grouped by type. In Tables 2 and 3, which are to be correlated, the percentages complaining and the excess rates are given. Besides clinic and total averages, there appear the individual figures for the lowest and highest units of each clinic, the complete details being of interest only to the treating staff. Malaise and weakness, chest oppression and chest pain, and lepra fever and cutaneous eruption are combined because evident irregularities in diagnosis make the separate figures of little value.

In connection with the irregularities of individual figures seen in these tables it may be said that, while the effect on the final totals is considerable in some cases, it is not usually so. It will be noticed that the clinic averages (of four units) are often roughly the average of the extremes given. Further to determine this, eight of the total averages have been compared with selected averages for the same symptoms obtained by arbitrarily eliminating the reports varying most widely from the apparent normal. In six instances the differences between the two figures so compared were not important; in the other two they were about 20 per cent of the original average. There is, then, as in such statistical work generally, a decided tendency for the extremes to neutralize each other.

TABLE 3.—*Excess frequency rates of various symptoms and incidents in patients complaining.*

[Rates in excess of one per person complaining.]

Symptom or incident.	Clinic I.			Clinic II.			Total average.
	Low unit.	High unit.	Average.	Low unit.	High unit.	Average.	
Choking	0	0.17	0.05	0	0.21	0.14	0.11
Dizziness	0	0.30	0.10	0	0.25	0.08	0.09
Induration	0.39	0.90	0.77	0.19	0.74	0.48	0.63
Headache	0	0.05	0.01	0	0.19	0.11	0.06
Malaise and weakness	0	0.27	0.06	0	0.17	0.09	0.08
Fever (simple)	0	0.24	0.12	0.05	0.35	0.16	0.14
Chest oppression and chest pain	0.05	0.16	0.10	0.02	0.56	0.25	0.20
Cough (only)	0	0.15	0.09	0.14	0.65	0.41	0.27
Cutaneous reaction and lepra fever	0.06	0.45	0.15	0.02	0.24	0.12	0.15
Eye inflammation	0	0.63	0.17	0	0	0	0.08
Rheumatic pain	0	0.67	0.07	0	0	0	0.04

Choking.—This occurred in 4.9 per cent of the patients. The percentages and rates of Clinic I are comparatively low, and the variation among the units is not important. In Clinic II, on the other hand, there is wide variation. Since the phenomenon is unmistakable, occurrences of it could not have been overlooked where low figures obtain; as has been said, the difference may perhaps be ascribable to differences of technic. In connection with the statement previously made that a few patients seem particularly liable to this occurrence, it may be remarked that four patients had it three times each in the two months.

Dizziness.—So far as the records show, this is an infrequent occurrence; one unit did not record it at all, though that does not, of course, prove it did not occur there. The suggestion comes to mind that, the average of Clinic I being twice that of Clinic II, the patients there may be less susceptible to respiratory tract irritation and that a goodly proportion of them experienced merely dizziness, whereas in Clinic II most had the more severe reaction.

Induration.—The wide variations here seen are undoubtedly due chiefly to differences in the attention paid this matter. While differences in proportion of patients under the most irritating preparation will affect the figures, as will be seen in the second paper, they are not sufficient to account for the figures. The total average, 21.3 per cent, is undoubtedly low,

though the highest figures are undoubtedly too high if only troublesome indurations are to be considered. The excess rates also vary widely, from 0.90 to as low as 0.19, the latter for a unit which also reported a very low percentage. The fact that the average frequency rate is much higher for Clinic I than for Clinic II must, particularly in view of the dosages given (Table 7), be ascribed to the personal equation, since it is improbable that the patients involved were so much more susceptible to local irritation.

Abscess.—This condition occurred too infrequently to necessitate special consideration. Three physicians did not report it, while the other five had a total of but nine cases.

Headache.—The irregularity of the percentages suggests that in some units little attention was paid to this complaint. The total average, 6 per cent, is low. According to the excess rates, comparatively few cases complained of this twice during the period. Actually, this trouble occurs very commonly within a few hours after injection, but it is ordinarily not complained of.

Malaise and weakness.—These were recorded much less frequently for the cases in Clinic I than for those in Clinic II; here two units recorded them in 14.8 and 17.2 per cent, respectively, though the others give but 3.0 and 4.2 per cent. It is believed that the former figures more accurately represent the true condition in that clinic. It is surprising that the frequency rates are so low, only three units reporting any duplication.

Simple fever.—Here again variations are wide, and the averages are believed to be too low. The greater total percentage for Clinic II is not surprising, but the nearly equal frequency rate is unexpected. It may be said that the highest percentage is reported by a physician, most of whose figures are very low, who some time ago was asked to make special observations on the occurrence of fever after injection. Slight rise of temperature following injection is very common, but it is usually not noticed by the patient; only fever sufficient to be recognized and complained of by the patient would be recorded here as it is quite out of the question to keep temperature records except in hospitalized cases.

Abdominal pain.—This symptom was not frequently reported and figures are not given. Six of the physicians recorded it in a total of but 23 cases.

Chilliness, insomnia, and anorexia.—These were recorded a few times by several physicians, but the number is small.

The first was recorded by five physicians in a total of 12 cases; the others were reported even less frequently.

Chest oppression and chest pain.—The number complaining of these symptoms (with or without cough) is rather high, particularly in Clinic II. Three units in Clinic I reported very uniformly, ranging only from 9.2 to 12.2 per cent; the fourth who, as will be seen, gives the smallest average dosage of all, records but 6.5 per cent, which may perhaps be accounted for on this ground. In Clinic II, two units with 32 and 22.8 per cent, respectively, are much higher than the other two, with but 15.2 and 13.8 per cent, though one of the latter gave comparatively high dosage. The differences between the averages for the two clinics, 9.9 as compared to 20.7 per cent, may be valid. The average frequency rates are nearly alike and are low, perhaps due to lowering of dosage or temporary suspension of treatment in cases complaining.

Cough (alone).—This complaint was naturally reported more frequently than the other chest symptoms, though probably too infrequently because patients are not apt to notice the lesser degrees of this. The average percentages for the clinics, 15.6 and 23 per cent, respectively, differ less than might be expected from the combined chest oppression and pain figures. It is suggested that the patients in Clinic I are on the whole in better condition as regards their chest condition and so have relatively more of the less marked symptom, while those in Clinic II tend to have the other complaints together with cough. In agreement with this is the comparatively high cough rate of this clinic, 0.41 against 0.09.

Hæmoptysis.—This symptom was recorded only by the four physicians of Clinic II, in 6 cases, which fact is in keeping with the other differences between the clinic groups as regards chest symptoms.

Cutaneous reaction and lepra fever.—The combined figures are comparatively very uniform; Clinic I averages the more, with 15.6 to 12.8 per cent. This is the only important symptom-group reported as occurring more frequently in that clinic. If reasonable regularity of recording be assumed, the suggestion arises that the generally more favorable cases of Clinic I are more prone to have this type of reaction. However, that they are so cannot be asserted on the basis of this analysis alone. As for the rates, certain of the comparatively very high ones

must be questioned. It is doubted that many patients had two distinct attacks of these reactions within so short a time.

Other probable "reaction" symptoms.—Eye inflammation occurred in approximately equal percentages in the clinics, totaling 2.6 per cent. Only one physician reported an excess rate; this (0.63) seems doubtful; the same disturbance, lasting more than one week, was probably recorded two or more times. Rheumatoid pain occurs infrequently and, naturally, somewhat irregularly, but the average percentages are practically equal. The same physician who reported a high rate for eye inflammation also reported 0.67 for this complaint, markedly in contrast to the others. Neuritis and orchitis were each recorded by but two physicians, one case each.

FREQUENCY OF SYMPTOMS BY TYPES

To summarize by types the complete data on occurrence of symptoms, not all of which are included in the tables given above, Table 4 has been prepared.

TABLE 4.—*Total frequency rates of complaints, by types and in total.*

[Rates per 100 patients treated.]

Complaints.	Clinic I.			Clinic II.			Total average.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Type 1, immediate	4.1	7.1	5.5	4.5	13.8	8.9	7.1
Type 2, local	19	73	36	12	74	33	34
Type 3, general	12	21	17	21	42	32	24
Type 4, respiratory	12	40	26	26	76	58	41
Type 5, reaction	14	34	23	13	25	20	22
Total	85	127	107	95	225	152	128

Of the total number of 3,601 complaints reported, but 45 per cent were reported from Clinic I, in spite of its greater registration in the groups under consideration. The total rates, 107 and 152, have a ratio of 1 to 1.42, almost half as many more per case treated than in Clinic II.

According to the total averages for the types it is seen that type 4 symptoms are the most numerous, due to their comparatively great frequency in Clinic II. Type 2 is the most frequent in Clinic I, and the second most frequent in the total average; the variation in recording this type is greater in both clinics than with any other, for in all others the clinic average approaches closely or attains the average of the extremes shown. Types 3 and 5 total nearly the same. As would be expected,

the former is much the more frequent in Clinic II. The latter, on the other hand, is slightly more frequent in Clinic I, suggesting that cases that are less advanced and more favorable for treatment are more apt to react in this manner to the treatment.

RELATION OF COMPLAINTS TO CERTAIN FACTORS

It is desirable to determine the relation of frequency and types of complaints to the factors of sex, age, duration of the disease, and variations in methods of treatment. In the present analysis, through oversight, data on duration were not obtained, but they have been obtained in connection with the comparisons made subsequently, and will be discussed in the third paper of the series. Only the total frequency rates are given in these analyses.

RELATION OF SEX TO NUMBERS COMPLAINING

The data have been tabulated only with respect to the number complaining; the figures are not presented, as no difference is found. The males constituted 65 per cent of the whole, the females, 35 per cent; of the former 70.7 per cent are recorded as having complained, of the latter, 70.3 per cent.

RELATION OF AGE TO COMPLAINTS

The factor of age in the production of complaints would be expected to be of little importance, since the age distribution of a leper population is very different from that of a normal population, the extremes being poorly represented. However, the figures show certain points of interest.

In Table 5 are given the percentage distribution by decades, the percentages of each group for whom complaints were reported, and the complaint rates.

TABLE 5.—*Distribution of cases by age groups, percentages of each complaining, and complaint rates.*

Age group.	Age distribution (percentages).			Patients complaining (percentages).			Excess rates (patient complaining).		
	Clinic I.	Clinic II.	Total.	Clinic I.	Clinic II.	Total.	Clinic I.	Clinic II.	Total.
Years.									
To 10	2.8	0.5	1.8	58	([a])	60	0.92	([a])	0.77
11 to 20	26.8	16.0	21.8	64	70	66	0.76	0.84	0.79
21 to 30	32.7	37.6	35.0	61	82	72	0.68	0.91	0.81
31 to 40	19.6	23.0	21.2	66	80	73	0.71	1.12	0.94
41 to 50	8.3	10.5	9.3	61	78	70	0.59	0.99	0.82
51 to 60	6.9	7.2	7.1	62	80	71	0.69	0.97	0.84
Over 60	2.8	5.0	3.9	60	70	66	1.00	1.13	1.08

[a] Too few to justify a figure.

Age distribution.—Of the 2,796 cases included in this analysis more than one-third are in the third decade. The second and fourth decades show nearly equal numbers. But 50 patients (1.8 per cent) were 10 years or less, most of them born at Culion; Clinic I has the majority of these. Probably not less than three-fourths of those in the 11 to 20 group are above 15 years, leaving roughly only 6 to 7 per cent of all at or below that age. As the dosage for those above 15 years has seldom to be modified on account of age, this factor is not important in that connection. At the other extreme only 11 per cent are more than 50 years old, and only 20 per cent are above 40 years of age; there is a predominance of these in Clinic II.

Calculating the average ages by multiplying the total number of cases in each group by the mean age figures, the figures arrived at are: Total, 30.3 years; Clinic I, 29.2 years, Clinic II, 32.2 years. The difference is undoubtedly more important as regards duration of the disease and, therefore, of the general condition of the patients than it may seem.

Complaints.—There is no marked variation with age in percentages complaining, there being only a slight and not regular increase in the middle-aged groups. There is, however, a decided increase in the excess frequency rates. Younger people may naturally be less apt to have complaints. Though the oldest may be more so, they are on the whole cases of longer duration in whom the disease is less active. Whatever difference there might be has evidently been in the main controlled by the fact that the clinicians adapt treatment to the individual cases.

Type complaints.—Though the total figures show little of interest, there are differences in the types, as is seen in Table 6. Here the data are given for twenty-year groups, but in the discussion the findings by decades will be referred to also.

TABLE 6.—*Relation of complaint types to age.*

[Rates per 100 cases in age group.]

Age group.	Number of cases.	Type 1.	Type 2.	Type 3.	Type 4.	Type 5.
Years.						
To 20	658	3.8	40	18	35	19
21 to 40	1,571	7.3	33	26	45	23
41 to 60	459	7.8	37	28	36	20
Over 60	108	10.2	38	25	37	27

Type 1 complaints increase decidedly with age, with three distinct phases. Up to 20 years the rate is about 4; from 20 to 60 years, about 7 to 8; and above that, over 10. The increase is, we assume, referable to the size of the venous channels. As the size increases with maturity, and again in those approaching senility in whom the increased size is associated with decrease in fat and in tone of the surrounding tissues, the chance of fortuitous intravenous injections increases. Type 2 complaints seem not to depend on age to any great extent, except that in the youngest they were most frequent. For the first three decades together the average rate (obtained from the original figures) is 34, that of the last four is 37, an insignificant increase. Type 3 complaints are considerably less frequent in the youngest, and fairly uniform in the older, according to the figures here shown; however, the first three decades average but 21, as compared with 29 for the last four. Type 4 complaints show no essential differences except for the high rate in the 21 to 40 group; however, the first decade actually has a low rate, the second approaching the highest rate here shown. In the three decades from 11 to 40 the rates average 43, in the last three, 36. Type 5 complaints are infrequent in the youngest and thereafter do not vary essentially. Indeed, the average rates for the three decades from 11 to 40 and of the three older ones are practically the same, 21.9 and 21.4, respectively. However, the highest figure is in the oldest group, a somewhat surprising finding.

RELATION OF TREATMENT FACTORS TO COMPLAINTS

The physicians' reports cannot be expected to yield direct or accurate information as to the kind or number of symptoms produced by various dosages and amounts of the drugs given. To obtain such data it would be necessary arbitrarily to fix these factors and to apply them inflexibly in strictly comparable groups of cases. This sort of experimentation is, of course, not permissible and has not been contemplated. The treating staff is primarily responsible for the welfare of the patients, and the methods must be varied to meet the needs of individual cases by reducing or increasing dosage, omitting injections, and even dropping patients from a group. By such clinical control the patients who complain most will be given the least treatment, and the degree to which this method is followed will

indicate the care exercised by the clinician. Of course, this care can be overdone, for in the interest of therapeutic effect it is better to push the medication, even at the cost of relatively unimportant disturbances, than to reduce it below an effective level.

In such an analysis the total figures for a group of physicians will be much more significant than will those for the individuals. Had each physician treated strictly comparable groups of patients and used exactly the same criteria and care in recording complaints, but used different methods, the results would be comparable; but when, as here, in a campaign in which an attempt is made to follow uniform methods, the personal equation leads different physicians to use distinctly different methods of treatment, it cannot be expected that close similarity in other phases of the work will be attained. Therefore, while the personal equation will probably not nullify the value of a comparison of drugs used by all physicians, it must be taken into account if any conclusion is to be reached in a comparison of methods.

Methods used.—To compare the methods and reported results of the individual physicians a summarization of the treatment factors for each clinic unit is given in Table 7, and of their complaint data in Table 8. In these only the cases receiving iodized preparations are considered, for in Clinic I those given the plain drug were injected twice a week and so are not comparable with the others. The plain-drug groups are, therefore, also eliminated from Clinic II figures, since this drug has complaint rates that were in certain respects unlike those of the iodized.

The distribution of dosage, etc., is in each case a condensation from a more-detailed tabulation and so arranged as to show what we consider low, medium, and high, respectively. The averages are calculated from the original tabulations, and while not as accurate as if they had been obtained by additions from the original detailed reports are sufficiently so for our purpose.

Inspection of Tables 7 and 8 shows considerable variations of practice in treatment and of apparent effects in the matter of complaints, with little indication of relationship between these. It would be fruitless to discuss them in detail, but a few features will be pointed out.

Altogether, one-third of the cases received low doses, and only 16 per cent fair to high doses (more than 3 cubic centimeters). Somewhat over one-half received a satisfactory number of injections, this influenced by the numerous extra doses in three units. Even so, but 21 per cent received more than 25 cubic centimeters. With an average dose of less than 3 cubic centimeters and an average total amount of 18 cubic centimeters in two months, the treatment given cannot be called intensive. Two factors outside the control of the physicians may have been responsible for this. One is the climatic condition, the period involved having been the hottest, most trying part of the dry season; the other is the medicaments used, the dosages, etc., of which are compared in the second paper of this series.

The Clinic I physicians gave on the average somewhat the lower dosage; that they had fewer complaints is not necessarily due to this factor. They also gave the most injections, whether the total figures be compared or those of units I,1 and I,3 with II,1; II,2; and II,3; these being the five in which few or no more than 9 injections were given in the two months. These averaged but 6 injections instead of the 6.67 of the table, and their average total amount is but 16.7 cubic centimeters.

The methods by which approximately similar average total amounts were attained are of some interest, as for example the differences in dosage and numbers of injections in I,3 and I,4. These are best seen in Table 8. From a comparison of the figures of II,2 and II,3 the impression would be gained that by giving smaller doses more injections can be given and so larger amounts, but on comparing the former with II,1 the opposite impression would be gained. It is impossible to arrive at any conclusion from these data.

Complaints to methods, by treating unit.—In comparing the complaint figures with the treatment practices (Table 8) another disturbing factor is introduced, that of variation in recording. In view of this and of the variations in method the fair uniformity of most of the figures on patients complaining in each clinic is surprising. In each there is one low figure; that for I,3 may perhaps be ascribable to the practice followed, but that in II,4 could hardly be so explained. There is, therefore, no apparent relation between the percentages complaining and the method. Neither is there any as regards the complaint rates.

TABLE 7.—*Dosage, numbers of injections, and total amounts of drug given, by clinic units.*[a]

[Percentages of patients under iodized preparations only.]

Clinic unit.	Cases.	Treatment factors.											
		Dose.				Number of injections.				Total amount.			
		1-2 cc.	3 cc.	+3 cc.	Average.	1-4	5-6	+6	Average.	0-5	15-25	+25	Average.
I, 1	324	41	53	5.9	2.62	22	37	41	5.96	49	45	5.9	15.3
I, 2	329	34	42	24	2.92	10	19	71	7.63	24	41	34	22.2
I, 3	314	9.1	90	0	2.89	12	31	56	6.59	28	61	11	18.2
I, 4	301	59	22	19	2.32	6.3	18	75	7.98	51	26	23	17.2
Total	1,268	36	52	12	2.69	13	26	61	7.03	38	43	19	18.2
II, 1	139	18	40	42	3.30	24	33	42	5.94	34	37	29	19.4
II, 2	155	39	44	17	2.74	23	37	39	6.03	49	30	20	16.9
II, 3	245	32	50	18	2.84	39	31	30	5.35	59	28	13	15.0
II, 4	202	27	51	22	2.95	12	19	68	7.34	22	40	38	22.2
Total	741	29	47	23	2.93	26	30	45	6.15	42	33	24	18.3
Grand total	2,009	33	50	16	2.77	18	28	55	6.67	40	40	21	18.2

[a] Numbers of injections and total amounts of drug given in units I,2; I,4; and II,4 increased by numerous extra injections during the period considered.

TABLE 8.—*Relation of complaints, total and by types, to treatment methods.*

[Patients under iodized preparations only.]

Clinic unit.	Treatment averages.			Patients complaining (per cent).	Complaint rates (excess).	Complaint type rates (total).				
	Dose.	Number of injections.	Total amount.			Type 1.	Type 2.	Type 3.	Type 4.	Type 5.
I,1	2.62	5.96	15.3	65	0.34	4.9	4.0	15	43	20
I,2	2.92	7.63	22.2	61	0.53	7.0	9.7	16	27	33
I,3	2.87	6.59	18.2	45	0.36	4.5	5.1	7.6	23	21
I,4	2.32	7.98	17.2	67	0.68	7.6	51	23	15	17
Total	2.69	7.03	18.2	59	0.49	6.0	17	15	27	23
II,1	3.30	5.94	19.4	76	0.58	6.5	2.9	32	63	16
II,2	2.74	6.03	16.9	86	1.39	13	31	46	90	26
II,3	2.84	5.35	15.0	80	0.83	20	5.3	22	75	24
II,4	2.95	7.34	22.2	56	0.39	11	2.5	25	21	19
Total	2.93	6.15	18.3	74	0.83	13	9.4	30	61	22
Grand total	2.77	6.67	18.2	65	0.63	8.7	14	21	40	22

The figures for complaint types also fail to show any regular relationship to method, though there are suggestions of this. Type 1 would be expected to be related chiefly to the number of injections and to be affected least by the personal equation; there is such an agreement in Clinic I, but not in all units of the other. There is no relation to dosage; indeed, unit I,4, with most 1 and 2 cubic centimeter doses, has the highest type 1 rate of that clinic. Type 2 would probably vary rather more with the size of dose than with the number of injections. Such a relation might be concluded from the figures of the first three units of Clinic I, but the variation in the other units is extremely great. That the figures for types 3 and 4 are not related to the treatment factors is not unexpected, because of modification of treatment when they occur. In Clinic I there is seen on the whole a direct variation of type 5 with the total amount of drug, but in Clinic II the reverse is found.

Complaints to methods, totals.—The total figures offer a more satisfactory basis for comparing the complaints with the treatment method. Each physician would use the same method of recording for his 2-cubic-centimeter group, for example, as for his 4-cubic-centimeter group, and the effects of differences of criteria and assiduity of recording in the group as a whole tend to be done away with by the averaging of the extremes. Further, the data on all treatment groups can be used in this analysis.

Dosage.—The data examined from this viewpoint are given in Table 9. Forty-eight per cent of all cases received medium

TABLE 9.—*Relation of complaints to dosage.*

Dosage.	Cases.		Patients complaining.	Complaint rates (excess).	Complaint type rates (total).				
					Type 1.	Type 2.	Type 3.	Type 4.	Type 5.
cc.	*Number.*	*Per cent.*	*Per cent.*						
1	197	7.0	68	0.89	6.1	33	31	34	24
2	812	28.8	78	1.01	7.8	44	23	53	39
3	1,362	48.4	67	0.75	7.0	27	24	40	20
4	398	14.1	69	0.57	6.5	41	22	26	14
5	49	1.7	55	0.66	6.1	31	26	22	6

average dosages, 2.6 to 3.5 cubic centimeters, and but 16 per cent received higher doses. In almost all columns of this table the 2-cubic-centimeter group has the highest figures, and usually the 1-cubic-centimeter has more than the 3-cubic-centimeter group. The numbers of patients complaining and the

total complaint rates decrease in the higher groups, with minor variations. As for the types, type 1 unexpectedly decreases from 7.8 in the 2-cubic-centimeter group to 6.1 in the +4-cubic-centimeter group, suggesting a tendency to susceptibility on the part of some patients with consequent reduction of doses. Types 2 and 3 show no regular variations except a drop from a maximum in the 1-cubic-centimeter group; evidently the dosage is on the whole reduced in proportion to the liability of the patients to complain of these disturbances. In types 4 and 5 the rates decrease markedly, indicating that they are considered important causes for reduced dosage. This was expected of the former, which are most important complaints. The reduction of dosage with the latter occurs both on resumption of treatment and during continued treatment in the mild reactions.

Numbers of injections.—The data on numbers of injections are given in Table 10. The distribution of cases here seen is modified by the inclusion of the group receiving plain ethyl esters twice a week; the last group comprises only such cases and so is not at all comparable with the others.

TABLE 10.—*Relation of complaints to numbers of injections.*

Number of injections	Cases.		Patients complaining.	Complaint rates (excess).	Complaint type rates (total).				
					Type 1.	Type 2.	Type 3.	Type 4.	Type 5.
	Number.	*Per cent.*	*Per cent.*						
1 to 4	574	20.4	87	2.16	7.3	31	31	78	39
5 to 8	1,632	57.9	69	1.72	6.3	33	22	39	19
9 to 12	566	20.1	56	1.76	9.9	40	24	14	10
+12	46	1.6	74	2.12	2.2	104	24	13	13

Except as affected by the last group referred to, there is a steady decrease in percentages of patients complaining, but in complaint rates only from the first and highest group. Type 1 is highest in the third group, as would be expected; that the first is higher than the second again suggests that some cases in the former group are susceptible to this disturbance, wherefore they are injected less frequently. Type 2 increases with the number of injections but not proportionately, because of clinical control. Type 3, as before, is practically uniform except that the first group is highest; actually, the patients responsible for this higher figure had received but one or two injections. In types 4 and 5 the rates decrease, as with dosage, but much more rapidly and markedly, indicating that the number of in-

jections is reduced more than the size of dose in patients complaining of them.

Total amounts of drug.—The complaint data arranged in relation to this factor are given in Table 11. Here less than one-half of the cases falling in the last group are of the twice-a-week plain-drug group, so the figures are more comparable with the rest of the table than those in Table 10.

TABLE 11.—*Relation of complaints to total amount of drug given.*

Total amount.	Cases.		Patients complaining.	Complaint rates (excess).	Complaint type rates (total).				
					Type 1.	Type 2.	Type 3.	Type 4.	Type 5.
cc.	*Number*	*Per cent.*	*Per cent.*						
To 10	618	21.9	83	2.13	7.7	32	29	69	38
11 to 20	1,124	39.9	74	2.62	6.8	36	24	44	22
21 to 30	763	27.1	59	1.66	6.5	33	22	25	12
31 to 40	245	8.7	60	1.62	10	34	27	16	9.3
+40	68	2.4	51	1.71	5.9	56	18	2.9	5.9

From Table 11 it is seen that 62 per cent of all cases received 20 cubic centimeters or less. The percentages complaining decline throughout, though not regularly. The complaint rates are much the same in the last three groups; the first two had comparatively very high rates. In other words, that so many patients were given small amounts was in the main because of comparatively very frequent complaints; that many (22.5 per cent) of these cases had no complaint during this period is, presumably, either because they persistently absented themselves or because of complaints previously suffered. It must be left to the treating physician when (and whether) cases in the latter category should, after a period of reduced treatment, later be given more-intensive treatment in the interest of improvement in the basic disease. Type 1 complaint rates are naturally irregular here, since they decreased with higher dosage and irregularly increased with frequency of injection. Type 2 rates, in spite of the upward trend with injections, vary as they did with dosage except in the last, the highest group. Type 3, as usual, shows no significant variation. Types 4 and 5, as always, decrease, and markedly so.

SUMMARY

The present series of papers deals in considerable detail with the various side-effects observed in and complained of by patients under treatment with chaulmoogra ethyl ester prepara-

tions. This is an important but hitherto not intensively studied phase of leprosy-treatment work, particularly in institutions in which advanced cases are dealt with. The first two papers are based on reports from the eight units of the two main treatment clinics, covering the period from April 15 to June 15, 1923. These reports were obtained primarily for the purpose of comparing, from this aspect, the 2 per cent iodized preparation of chaulmoogra ethyl esters (theretofore extensively used) and a 0.5 per cent iodized preparation. The comparison was extended to include the groups under the plain (noniodized) ethyl esters. The present paper deals with the relation of general factors to the complaints reported, without regard to the preparations used; the comparative data are presented in the second paper.

From the nature of the data it is not possible to draw as accurate conclusions as if the treating physicians were required to apply uniform, standardized methods; it is considered necessary to allow them wide latitude in dealing with the cases for whose welfare they are immediately responsible. The personal equation affects or determines the findings in certain analyses, but in others it is neutralized; on the whole, the findings are believed to be significant. Not only are variations seen in the individual unit reports, but there are decided differences between those of the two clinics, for which reason the clinic totals frequently have to be considered separately. The difference is no doubt in some part due to differences in the patients treated, those in Clinic I having been to a considerable extent selected, and under treatment longer; but there is evidence that the personal equation is an important factor.

The total number of treated patients on which the first two reports are based is 2,818. Their distribution by treatment units is given (Table 1), together with the numbers of patients reported by each physician as complaining. A little more than one-half of the cases were in Clinic I. Seventy per cent of all were credited with complaints. In Clinic I 63 per cent were so reported; in Clinic II, 79 per cent.

The complaints recorded fall into five natural groups or types: (1) Immediate effects (coughing and choking, and dizziness), which are temporarily disturbing, even alarming to the patient, but not particularly important; (2) local effects (inflammation and abscess), which are undesirable in that they tend to discourage the patient if frequently repeated; (3) general symptoms (headache, malaise, simple fever, etc.), of variable

importance but on the whole undesirable; (4) respiratory tract symptoms (chest pain and oppression, and cough), the most important of the group because of the frequency of pulmonary tuberculosis in lepers and the tendency of the drug to aggravate this; and (5) lepra reaction symptoms (lepra fever, cutaneous eruptions without fever, etc.), the milder forms of which may be desirable. A sixth group, referring to kidney disturbances, should be distinguished, but this could only be done on the basis of frequent urinalyses of all cases under treatment.

In considering the frequency of complaints, both the percentages of patients complaining and the number of complaints are taken into account. The latter are treated either as "total" rates (per 100 cases in the entire group considered) or as "excess" rates (the number in excess of one per patient complaining).

The frequency of the principal individual incidents is shown (Tables 2 and 3) in percentages and excess rates. Though the unit reports vary more or less widely, in most instances the clinic averages are valid for purposes of comparison with each other, though their absolute values may be far from accurate. Of type 1 complaints, a total of 4.9 per cent of those treated were credited with choking, with an average excess rate of 0.11. These were the more frequent in the Clinic II cases. Dizziness, on the other hand, with 1.5 per cent, occurred in relatively more Clinic I cases. Of type 2, abscesses were infrequent. Induration was reported extremely irregularly. The general average, 21.3 per cent, is believed much too low, though the average rate, 0.63, seems more nearly correct. Of type 3, headache was recorded very irregularly. Malaise and weakness were, as would be expected, much the more common in Clinic II, 9.9 per cent as compared with 3.4 per cent. The figures for simple fever are less different. Chest oppression and chest pain (type 4) are very important complaints. Fifteen per cent of all complained of these, 9.9 per cent in Clinic I and 20.7 per cent in Clinic II. Though simple cough is less apt to be complained of and recorded, the figures are somewhat higher, with 19.1 per cent of the total complaining. The clinic averages differ less than their rates. Hæmoptysis was reported only from Clinic II. The findings are in keeping with the fact that the Clinic I cases are decidedly the better off as regards pulmonary complications. Cutaneous reaction and lepra fever, unlike most others, have the higher percentages in Clinic I, 15.6 to 12.8, suggesting that these more favorable cases are

somewhat the more prone to these disturbances. The minor disturbances of this type occurred practically equally in the two clinics.

Since in the further analyses the complaints are considered by types rather than individually a summary of the percentages of all complaints of each type is given (Table 4). The ratio of total complaints is 1 for Clinic I to 1.42 for Clinic II. Type 4 has the highest percentage, though it is believed that type 2, which is second, should be first, and type 3 second. As reported, the totals for types 3 and 5 are nearly equal, though the clinic totals differ, the former being more frequent in Clinic II and the latter in Clinic I. It is probable that the figures for types 1, 4, and 5 approach the actual.

The relation of frequency of complaints to the factors of sex, age, and method of treatment, referring to average dosage, number of injections, and the consequent total amount of drug given each case, has been examined in some detail.

There is practically no difference in the number of patients of each sex who complained, the percentage of males being 70.7 and of females 70.3.

The generally low age of leper populations is seen here (Table 5), nearly 60 per cent being 30 years old or less; the average is about 30.3 years. Few (1.8 per cent) are 10 years old or less; most of these were born at Culion. The age distribution in the clinics is not uniform, the average for Clinic I being 29.2 and that for Clinic II, 32.2, a difference of some importance in connection with duration.

As would be expected in so abnormal a population, little relation is seen between age and the frequencies of total complaints, there being only a slight rise to the fourth decade. However, this is not true of the types (Table 6). Type 1 increases with age, being least in children, whose blood vessels are small, and most in the aged, approaching senility. Type 2 is comparatively high in children, and slightly lower in young adults than in the older. Type 3 is lowest in the youngest but comparatively uniform thereafter. Type 4, also lowest in the youngest, is highest in the younger adults. Type 5 is on the whole not essentially different after the low youngest group except for a somewhat higher rate in the most aged, the last an unexpected finding.

In considering the relation of treatment factors to complaints it is not to be expected that a direct relationship would be seen between the intensiveness of treatment and the numbers of com-

plaints, even were there no individual differences in recording, for it is obligatory on the clinician so to adjust his treatment as to minimize disturbing side-effects. Two trends are seen, the natural one due to direct effect of the drug, and the artificial one due to clinical control. The latter, naturally, is predominant and usually causes the figures to fall with increase of treatment rather than the natural reverse.

For purposes of orientation, the methods of each physician are first examined (Table 7), and the complaint figures in relation to these (Table 8). Wide variations are seen in dosage practices, numbers of injections, and consequent total amounts of drug given. The general average dose is but 2.77 cubic centimeters, slightly less in Clinic I, more in Clinic II. Even with fairly numerous injections the total amount is low, averaging but about 18 cubic centimeters in two months. The average number of injections for those actually giving the drugs but once a week is 6, and the average total amount is but 16.7 cubic centimeters. This is not intensive medication. Whether the climatic conditions or the preparations used influence this cannot be said.

The attempt to correlate the complaint data with the treatment methods of the individual workers is rendered entirely unsatisfactory by the unavoidable personal factor in the matter of criteria as to what should be recorded and, apparently, in regularity of recording. No apparent relationship is seen with the numbers of patients complaining or the total complaint rates, though with certain of the types there is an indication of the expected relationship.

In analyzing the total figures for complaints with relation to the treatment factors of dosage (Table 9), numbers of injections (Table 10), and total amount of drug given (Table 11), the influence of the personal equation is more or less overcome, since the extremes tend to neutralize each other. Due to clinical control of treatment, the percentages complaining decrease in all three analyses, most markedly in relation to total amount because this reflects the combined decreases with dosage and numbers of injections. The complaint rates, however, do not decrease so regularly, showing a rise in the highest group in each table.

In these analyses the rates for type 1 tend to decrease in the higher-dosage groups, suggesting that there are a certain number of cases particularly susceptible to this reaction and therefore given less treatment (clinical control), while they increase

somewhat with increased injections (modified natural effect). Type 2 shows the natural increase with number of injections, though much less than if not largely controlled clinically. The rates do not increase with this factor. Type 3 is most frequent in all the lowest groups, but thereafter shows no definite tendency, evidently being controlled sufficiently to prevent an increase in rates, though not enough to cause a decrease; this is probably because it is more important to give as much medicine as possible than to avoid these complaints entirely. Types 4 and 5 both decrease markedly with dose and number of injections, and consequently with the total amount. It is evident that the complaints of these types are watched most closely and the treatment methods modified because of them more than with any other complaint.

CONCLUSIONS

Few conclusions are to be drawn from this paper, both because of its general nature and the influences affecting the data, though several points of interest are seen. The importance of complaints of patients in modifying the methods of treatment is emphasized. Their kinds and classification are discussed and so far as possible their relative frequencies as met with in this colony determined.

The sex of patients has no apparent influence on the number of patients complaining.

Age has little relation to the total numbers of complaints, but local irritation is apparently most frequent in the youngest, and most of the other conditions least frequent. Coughing and choking and lepra reactions are most frequent in the aged.

Wide variations in the reports of the individual physicians prevent drawing conclusions as to the effect of different tendencies in administering medication. It is found that on the average the amount of medication given during the period involved was decidedly not intensive.

Analysis of the general relation of treatment methods to complaints shows little of the natural relationship between dosage, etc., and frequency of the various complaints, indicating clearly that the treatment staff as a whole has been careful to modify the administration of the drug to the side-effects produced, particular attention having evidently been paid to the dangerous respiratory tract symptoms and to lepra reactions.

COMPLAINTS OF PATIENTS UNDER ANTILEPROSY TREATMENT, II

COMPARISON OF PLAIN CHAULMOOGRA ETHYL ESTERS AND TWO IODIZED PREPARATIONS [1]

By H. W. Wade

Chief Pathologist, Culion Leper Colony, Philippine Health Service

TOPICAL SUMMARY

INTRODUCTION

In the first paper of this series, based on reports obtained primarily for the purpose of comparing the frequency and kinds of side-effects observed in patients receiving plain and two iodized preparations of chaulmoogra ethyl esters, the general features of the matter were discussed. In the present paper the data for each of the preparations will be compared, in general along lines previously followed.

Late in 1921 the special treatment staff then at work decided that chaulmoogra ethyl esters constituted the medication of choice for general adoption. It had a decided advantage over the sodium salts of chaulmoogra and cod-liver oils in that these,

[1] This report is based on data obtained during the temporary service of the writer as acting chief physician and, as such, chairman of the staff committee controlling the treatment work. Acknowledgment is made of indebtedness to the clinic physicians on whose records the analysis is based. Published with the consent of the Director of Health and the approval of the Philippine Leprosy Research Board.

being given intravenously, required more time and skill to administer, which tended to limit the number of cases that could be treated, and that they could not be so given indefinitely on account of obliteration of the veins. The so-called Mercado mixture, used in parallel with these, seemed to have less therapeutic effect. In this preliminary work the ethyl esters were used without adjuvant, as it was desired to determine the merits of the basic medication. All of the first group of five hundred selected cases were given this thereafter. When antileprosy treatment was extended to more patients, the 2 per cent iodized preparation as then used in Hawaii was tried out and was found so much less irritating at the injection site that all of the new cases were put under it. By the first of January, 1922, approximately five hundred cases were receiving it, and by April 1, practically one thousand.

When the treatment staff was enlarged and a second clinic organized, late in March, 1922, it was decided that the cases treated there should be so divided between the plain and the iodized preparations as to permit a direct comparison of the therapeutic effect of the two. This could hardly be done in Clinic I, for the patients in the plain-drug group were comparatively few, had been somewhat carefully selected, had received treatment for a longer time, and were being injected twice a week, whereas those given the iodized preparations had not been so carefully selected and were being injected but once a week. Thus are explained certain differences in distribution of cases and treatment methods in the two clinics, and also in some part at least differences in the data reported.

In the course of time some of the staff members gained the impression that the iodine gave rise to certain side-effects on its own account. At the same time preliminary surveys of results of treatment had indicated that the iodine has no value whatever except that, in reducing the irritating quality of the plain drug, it permits somewhat more intensive medication. Assuming the latter finding to be correct, it was felt that it might be advantageous to reduce its concentration, provided, of course, that this reduction should not go to the extent of lessening its beneficial effect in decreasing irritation. It was therefore decided by the staff committee to try extensively a 0.5 per cent iodized preparation. The treating physicians were instructed to divide their iodized groups into two more or less equal subgroups, one to receive the new preparation, the other to continue under the old one to serve as the control. A little over two months

later the staff was requested to report on treatment given and complaints recorded for these groups, between April 15 and June 15, 1923, and for comparison similar data for the patients receiving the noniodized drug. It was realized that it would have been desirable to have a longer period elapse between instituting the new preparation and taking records for comparison, to allow the group under it to come to an equilibrium, as it were, but it was preferred not to delay in the matter. In spite of the shortness of the period, as will be seen, the results seem to be decisive.

DISTRIBUTION OF DRUG GROUPS

The basis on which the cases were supposed to be distributed in the three main treatment groups was not followed exactly, as is seen from the percentages in Table 1. Here, as in the other tables, self-explanatory symbols are used to indicate the drugs.

TABLE 1.—*Distribution of cases, by preparation.*

Clinic unit.	Number of cases.	C. E. I. 2 per cent.		C. E. I. 0.5 per cent		C. E.	
		Number.	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*
I, 1	392	186	47	138	35	68	17
I, 2	360	185	51	144	40	31	9
I, 3	375	158	42	156	42	61	16
I, 4	382	154	40	147	38	81	21
Total	1,509	683	45	585	39	241	16
II, 1	291	70	24	69	24	152	52
II, 2	365	60	16	95	26	210	58
II, 3	355	164	46	81	23	110	31
II, 4	298	86	29	116	39	96	32
Total	1,309	380	29	361	28	568	43
Grand total	2,818	1,063	38	946	34	809	29

The total figures show a roughly equal distribution, more or less a third for each preparation, but the clinic figures differ decidedly. In Clinic I, where the great majority had been receiving the iodized, these were on the whole sufficiently equally divided in each unit; therefore, individual variations in practice of reporting complaints cannot affect seriously the comparison of these preparations. This is hardly true of the plain-drug group, for which the percentages range from 9.6 to 21. However, as these cases were supposed to be injected twice a week, in most instances their data cannot be used in comparisons with the iodized-drug groups. In Clinic II the variation

is more marked, which is unfortunate in view of the individual variations in reporting that have been seen in the first paper. The plain drug was being given to over one-half by two physicians, and to but one-third by the other two. The iodized-drug cases were in three instances not divided into even roughly equal groups. The 2 per cent groups vary from 16 to 46 per cent of the unit lists, and the 0.5 per cent from 23 to 39.

If the preparations differ widely in the frequency with which they cause complaints, as will be seen to be the case, this irregularity may help to explain some of those in complaint figures seen in Table 8 of the preceding paper. In the present connection, though it will not affect the individual unit rates for each drug, it will affect the total clinic rates. However, in analyses where figures from the entire staff are involved the extremes tend to neutralize each other, giving more dependable statistics.

NUMBERS COMPLAINING, BY TREATING UNITS

In connection with the possible effect of the personal equation on the figures obtained in the present inquiry, the percentages of patients reported from each clinic unit as complaining are shown in Table 2. For correlation, there are also given what are here called the "excess" complaint rates, indicating the average number of complaints reported in excess of one per patient for whom any complaint was reported.

It would appear from the first section of Table 2 that in four units the plain drug caused most patients to complain, in one instance more than twice as many as either of the other preparations; three units give this preparation practically the same as one or other of the iodized, while one gives it less than either. Comparing the 2 per cent and 0.5 per cent iodized preparations, four units give the former decidedly higher percentages, three give them practically equal figures, and one gives the latter the higher. These differences may be due to clinical control of the treatment; for instance, a unit (II, 3) that has the lowest percentage in the plain-drug group gave the lowest average total amount of drug (Table 7, previous paper); enough less may have been given to the group under this than to the others to prevent complaints. The data for the individual units have not been examined from this viewpoint.

TABLE 2.—*Percentages of cases complaining, by preparation and physician.*

[Complaint rates in excess of one patient complaining.]

Clinic unit.	C. E. I. 2 per cent.		C. E. I. 0.5 per cent.		C. E.	
	Complaining.	Complaints.	Complaining.	Complaints.	Complaining.	Complaints.
	Per cent.	*Rate.*	*Per cent.*	*Rate.*	*Per cent.*	*Rate.*
I, 1	63	0.35	68	0.33	85	1.52
I, 2	71	0.53	48	0.54	84	2.04
I, 3	44	0.40	46	0.32	97	1.15
I, 4	74	0.87	59	0.44	73	1.49
Average	63	0.55	55	0.40	83	1.48
II, 1	76	0.62	75	0.54	94	0.66
II, 2	90	1.61	84	1.24	92	1.60
II, 3	79	0.86	81	0.77	71	0.58
II, 4	69	0.66	47	0.11	71	0.81
Average	78	0.91	70	0.73	85	1.21
Total average	68	--------	61	--------	84	--------
Percentage averages:						
Clinic I	63	0.54	55	0.41	85	1.55
Clinic II	78	0.94	72	0.66	82	0.91
Total	71	0.74	64	0.53	83	1.23

The actual clinic averages, obtained from the original figures, are alike in giving the highest figures to the plain drug and the lowest to the 0.5 per cent iodized. The percentages for the former in the two clinics are nearly alike, but it would seem as if in Clinic II less difference was seen between the iodized and the plain preparations. The real explanation undoubtedly lies in the more frequent injections of the plain drug given in Clinic I, which apparently increased the complaints, thus raising the usually lower figure of that clinic.

The rates here given also show decided differences in different units, both absolutely and in the comparison, but the averages for both clinics place the preparations in the same order as before.

To test what effect differences in number of cases under each physician may have on the average figures, the unit percentages have been averaged directly. Thus are given the averages that would have been obtained if all physicians had had the same number of cases under each preparation. Several figures

change a little, but none markedly. This effect may, therefore, be ignored.

FREQUENCY OF COMPLAINTS

INDIVIDUAL SYMPTOMS

Though in subsequent analyses complaints will be treated by types rather than individually, it is well first to examine the frequencies of the more important symptoms under each preparation. In Table 3 the groups for the two iodized preparations are totaled for comparison with the plain. Both percentages complaining and excess rates are given.

TABLE 3.—*Comparing frequency of symptoms in cases under plain and iodized esters.*

[Complaint rates in excess of one per patient complaining.]

Symptom.	Plain esters (809 cases).		Iodized esters (2,009 cases).	
	Complaining.	Complaints.	Complaining.	Complaints.
	Per cent.	*Rate.*	*Per cent.*	*Rate.*
Choking	1.9	0.27	6.1	0.09
Dizziness	1.0	0.00	1.7	0.01
Induration	48.0	0.78	10.0	0.34
Headache	5.9	0.02	5.6	0.09
Malaise and weakness	9.3	0.08	4.9	0.09
Fever (simple)	13.0	0.18	7.7	0.11
Chest oppression and pain	14.0	0.10	15.0	0.24
Cough (only)	22.0	0.02	16.0	0.32
Lepra reactions	13.0	0.23	14.0	0.13
Eye inflammation	2.1	0.07	2.8	0.09
Miscellaneous	1.6	0.08	3.5	0.03

Choking and dizziness are both commoner with the iodized; the former occurred in more than three times as many persons per hundred under this preparation as with the plain. The frequency rates, however, do not correspond with this, but this lessens the difference only slightly. On the other hand, nearly five times as many patients under the plain were reported as having complained of local irritation, with much higher rates. Nearly twice as many under the plain complained of malaise and weakness and of simple fever. The headache figures show no real difference, there being a slight advantage for one in the percentages and for the other in the rates. Chest oppression and pain have also very similar percentages, though a somewhat higher rate with the iodized. Cough has somewhat

the higher percentage with the plain, but a much higher rate with the iodized, thus probably neutralizing any advantage. Lepra reactions are practically the same in both, except that the rate is higher with the plain. Eye inflammation, a somewhat infrequent complaint, occurred only one-third more frequently with the iodized, which is not in agreement with the impression that some had gained that it is much commoner with this preparation. Miscellaneous complaints (rheumatic pain, neuritis, and orchitis) were much more frequent with the iodized, but the total is so small that, though this relation is of interest, it is hardly important.

It having been seen that each of these preparations is the more productive of certain complaints, though on the whole the iodized has the advantage, it remained to determine similarly whether either of the two iodized preparations has any advantage in this respect. The findings are given in Table 4.

TABLE 4.—*Comparing frequency of symptoms in cases under 0.5 per cent and 2 per cent iodized esters.*

[Complaint rates in excess of one per patient complaining.]

Symptom.	C. E. I. 2 per cent (1,063 cases).		C. E. I. 0.5 per cent (946 cases).	
	Complaining.	Complaints.	Complaining.	Complaints.
	Per cent.	*Rate.*	*Per cent.*	*Rate.*
Choking	7.8	0.12	4.1	0.02
Dizziness	1.8	0.00	1.7	0.12
Induration	12.0	0.39	8.3	0.25
Headache	5.7	0.05	5.4	0.14
Malaise and weakness	4.8	0.04	5.0	0.15
Fever (simple)	8.1	0.14	7.3	0.07
Chest oppression and pain	15.0	0.25	15.0	0.22
Cough (only)	17.0	0.36	14.0	0.27
Lepra reactions	15.0	0.14	12.0	0.11
Eye inflammation	2.7	0.00	2.8	0.18
Miscellaneous	4.1	0.00	2.8	0.07
Total	95.0	0.21	79.0	0.15

The 2 per cent preparation is seen to have much the higher figures for choking, and somewhat so for simple cough, indicating that it is more irritating to the respiratory tract. Chest oppression and pain figures, however, are practically the same. As regards dizziness there is no important difference. The 2 per cent preparation has distinctly the worse figures for local irritation, indicating that in this concentration the iodine not only has

done as much as possible in reducing the irritating effect of the ethyl esters, but has begun to show one of its own; while 0.5 per cent concentration is not necessarily the optimum, it is clearly the better of the two used. In the type 3 symptoms (headache, malaise, and simple fever) the 2 per cent has, on the whole, slightly higher percentages, while the 0.5 per cent has moderately higher rates with two of these symptoms. In view of the fact that the plain drug gives the highest rates, it may be that 0.5 per cent is not sufficient to overcome this tendency. However, the difference is not great and may possibly be due to other factors. Lepra reactions and miscellaneous complaints are both somewhat the more numerous with the 2 per cent preparation. Eye inflammation, with practically equal percentages, has a higher rate with the 0.5 per cent, which indicates that the iodine content has little if any direct relation to this disturbance.

COMPLAINT TYPES

This question of the relative frequency of symptoms is summarized in Table 5, in which the "total" rates for the total of symptoms of each type are given for each preparation.

TABLE 5.—*Comparison of frequency of complaints, by types.*

[Total complaint rates per 100 cases treated.]

Complaints.	Plain (809 cases).	2 per cent iodized (1,063 cases).	0.5 per cent iodized (946 cases).
Type 1	3.1	11	6.3
Type 2	85	17	11.0
Type 3	32	21	20
Type 4	43	42	37
Type 5	19	25	20

As has already been seen, the plain drug has decidedly the advantage as regards the type 1 disturbances; the 0.5 per cent is, in turn, better than the 2 per cent. When the symptoms are thus combined the more weakly iodized has the advantage over the others in types 2 and 4, and is certainly no worse than the 2 per cent in type 3. With type 5, it is practically the same as the plain drug, and distinctly better than the 2 per cent iodized. From this analysis of total numbers of complaints it is decidedly the preparation of choice.

RELATION OF COMPLAINTS TO CERTAIN FACTORS

RELATION OF AGE TO TOTAL COMPLAINTS

In the general analysis it was found that there was no marked relation between the age of the patient and the total complaints, though certain of the complaint types did vary with this factor. In Table 6 this analysis is applied to the different preparations, the total rates for the different age groups being shown.

TABLE 6.—*Relation of number of complaints to age, by preparation.*

[Total complaint rates, per 100 cases in groups.]

Age group.	C. E. I. 2 per cent.	C. E. I. 0.5 per cent	C. E.
Years.			
To 20 [a]	108	81	182
21–30	120	92	185
31–40	130	106	194
41–50	110	92	187
51–60	119	85	182
Over 60	83	166	184

[a] Cases in first decade too few for accurate rates except in C. E. I. 2 per cent.

Here are distinct differences. With all three the highest group is in the fourth decade, as was the total in the general analysis. With the plain drug there is little decrease from this in either direction; on the whole, its rates vary but slightly. With both iodized preparations there is a decided drop in both directions; but in the oldest group, under the 0.5 per cent there is a marked rise, to twice that of the preceding group. Though there are but twenty-four patients in this group, the number is sufficient to make the rate of some significance. As will be seen, this is the only instance in which this preparation has such a change of trend. On analysis by types, not shown here, this increase is found to occur in all but type 2, which indicates that it is not fortuitous; no type increases, in this age group, with the 2 per cent preparation.

RELATION OF TREATMENT FACTORS TO COMPLAINTS

In the general analysis it was seen that the total number of complaints decreases somewhat in the higher-dose groups, and markedly in those given the most injections and, therefore, in those given the largest total amounts of drug. The data

for the three preparations used will now be examined to see whether they differ in this respect. Only the total complaints will be considered except in the analysis by total amount of drug given.

Dosage to total complaints.—The distribution of cases and the total complaint rates are given in Table 7. Here one rate is inclosed in double parentheses, because the group involved comprises less than ten cases, which makes the rate very unreliable; in Table 9 are rates based on more than ten but less than twenty cases; these are inclosed in single parentheses because still comparatively unreliable. Because the +4-cubic-centimeter groups are very small (20, 20, and 9 cases, respectively), the cases involved must be considered exceptional; therefore, the rates for the combined 4 and +4-cubic-centimeter groups given in the last line are more suitable for comparison with the other groups.

TABLE 7.—*Relation of dose to number of complaints, by preparation.*

[Total complaint rates, per 100 cases in groups.]

Average dose.	Preparation.					
	C. E. I. 2 per cent (1,063 cases).		C. E. I. 0.5 per cent (946 cases).		C. E. (809 cases).	
	Per cent of cases.	Complaint rate.	Per cent of cases.	Complaint rate.	Per cent of cases.	Complaint rate.
cc.						
1	7.0	132	6.5	100	7.4	157
2	28	144	25	107	34	211
3	50	105	50	90	43	174
4	13	95	16	84	14	161
+4	1.9	100	2.1	60	1.1	((144))
4 or more, combined	15	96	18	81	15	160

The 0.5 per cent iodized preparation has the advantage in that more patients under it were given higher doses, 18 per cent receiving more than 3.5 cubic centimeters as compared to 15 per cent with the other two preparations. In the lower groups the 0.5 per cent has fewest, the plain drug most.

The complaint rates at both extremes are best for the more weakly iodized, poorest for the plain. With all preparations they decrease with increase in dose, but not to the same extent. From the maximum to the average high-dose rates (last line), the decreases are, respectively, 33, 24, and 24 per cent of the maximum figure. By this the 2 per cent iodized has the greater

drop, but as the 0.5 per cent has the lower figures throughout (as well as an actually considerably greater drop in the +4-cubic-centimeter group), this can hardly be said to be a real advantage. Though the percentages of decrease for the 0.5 per cent iodized and the plain are the same, these preparations are not to be compared, on account of the very high rates of the latter.

Numbers of injections to total complaints.—In this analysis (Table 8) distinction is made between the plain-drug groups of the two clinics, because injections were supposed to be given semiweekly in Clinic I.

TABLE 8.—*Relation of number of injections to number of complaints, by preparation.*

[Total complaint rates, per 100 cases in groups.]

Number of injections.	Preparation.							
	C. E. I. 2 per cent (1,063 cases).		C. E. I. 0.5 per cent (946 cases).		C. E. (Clinic I) (240 cases).		C. E. (Clinic II) (569 cases).	
	Per cent of cases.	Complaint rate.	Per cent of cases.	Complaint rate.	Per cent of cases.	Complaint rate.	Per cent of cases.	Complaint rate.
1 or 2	3.5	203	3.8	158	2.9	((100))	8.3	217
3 or 4	14	189	14	145	7.1	312	27	224
5 or 6	27	114	28	124	13	238	37	179
7 or 8	31	94	33	68	24	233	23	138
9 or 10	20	98	17	58	18	216	6.0	88
11 or 12	4.7	104	3.7	40	15	211	--------	--------
13 or 14	--------	--------	--------	--------	8.3	200	--------	--------
More than 14	--------	--------	--------	--------	11	115	--------	--------

The 2 per cent iodized has here a very slight apparent advantage over the 0.5 per cent in the distribution of cases. But this is the result of differences in methods; for in the reports of the five physicians who gave few or no cases more than 9 injections, 26 per cent under the 2 per cent received 4 or less against 18 per cent under the 0.5 per cent. The plain drug is far worse than the others in the numbers given few injections, particularly so in Clinic I since, on a twice-a-week basis, the four groups including from 1 to 8 injections are together equivalent to but two groups on the once-a-week basis. In Clinic I, 47 per cent of the cases fall within this low limit; in Clinic II, but 34 per cent. Therefore, few of these twice-a-week patients were injected with anything approaching regularity, as a result of which only a moderately larger amount of drug

was administered than in Clinic II, perhaps not much more than the differences in the cases themselves would explain.

The decreases in complaint rates with increase in number of injections, seen in the general analysis, are here seen in each group. As in Table 7, with the 2 per cent iodized preparation there is a terminal rise, whereas in the others there is a steady decrease after the maximum. The rates for the weekly plain-drug group decrease 61 per cent from its high maximum of 244, and in the semiweekly 63 per cent from the very high maximum of 312. For the 0.5 per cent iodized the decrease is 75 per cent from its comparatively low maximum of 158, while the lowest rate for the 2 per cent iodized is but 54 per cent less than the maximum, and that for the last group only 49 per cent less. This advantage for the 0.5 per cent iodized preparation is important.

Total amounts of drug to total complaints.—The figures on this factor (Table 9) naturally show the same variations as do those on dosage and on numbers of injections, though not in the same degree.

TABLE 9.—*Relation of amount of drug to number of complaints, by preparation.*

[Total complaint rates, per 100 cases in groups.]

Amount of drug.	Preparation.							
	C. E. I. 2 per cent (1,063 cases).		C. E. I. 0.5 per cent (946 cases).		C. E. (Clinic I) (240 cases).		C. E. (Clinic II) (569 cases).	
	Per cent of cases.	Complaint rate.	Per cent of cases.	Complaint rate.	Per cent of cases.	Complaint rate.	Per cent of cases.	Complaint rate.
cc.								
To 5	5.3	186	4.6	165	7.1	(165)	8.4	196
6 to 10	15	167	16	132	10	204	21	230
11 to 15	20	130	18	110	13	263	23	174
16 to 20	20	102	22	90	17	225	20	194
21 to 25	18	86	19	65	19	233	15	137
26 to 30	8.5	83	11	64	12	222	6.3	128
31 to 35	7.1	99	5.7	63	6.3	(220)	4.4	112
36 to 40	5.5	98	3.7	51	6.7	(131)	1.4	((12))
+40					8.3	120		

The disadvantages of the plain drug show up clearly here, 52 per cent receiving 15 cubic centimeters or less, and 72 per cent 20 cubic centimeters or less. Even in the twice-a-week group 31 and 47 per cent, respectively, are within these limits. Comparing the two iodized preparations, but 31 per cent of

the weaker received 15 cubic centimeters or less as compared with 41 per cent for the stronger, though on the 20-cubic-centimeter basis there is apparently no difference, 61 per cent of both groups being within this limit. But this again is because of extra injections for, in the five units not giving these, 54 per cent of the 2 per cent iodized received 15 cubic centimeters or less against only 35 per cent of the 0.5 per cent, while with the 20-cubic-centimeter limit the percentages are 81 and 55, respectively. This advantage for the 0.5 per cent is important, particularly when it is realized that this preparation caused decidedly fewer side-effects.

The amount of decrease in complaint rates for the plain drug in Clinic II, if we ignore the extraordinary last figure, is 51 per cent from the maximum of 230, and in Clinic I it is much the same, 54 per cent. The 0.5 per cent iodized decreases 69 per cent, but the 2 per cent iodized only 55 per cent at the minimum, and but 45 per cent in the last group.

In summary, it is seen from these analyses that even in the long-treated, selected Clinic I group the plain drug, which causes the most complaining, has the least decrease in rates in the cases receiving the more intensive treatment. That is, fewer patients are able to receive such treatment with few or no complaints. There is no reason to believe that the frequency of side-effects could not have been controlled with the plain drug as well as with the other preparations, but it is evident that this was not done, because to do so would have limited the amount given so much as to reduce unduly its therapeutic effect.

Both iodized preparations are far preferable in this respect, but even here there are distinct differences. Not only does the weaker preparation have lower rates in every instance, but these decrease more markedly from the maximum. Furthermore, they continue to decrease even in the most intensively treated groups, whereas the 2 per cent drug shows an upward trend in these, a peculiarity that is probably referable to the iodine itself, which is apparently present in excess.

Total amounts of drug to complaint types.—In a similar analysis of the total data [2] it was seen that not all types of complaints followed the trend of the total figures. This is a consideration of some importance for, if the more serious complaints (type 4 particularly) were not readily controlled clinically with

[2] Antea, p. 686.

one or another drug, this would affect the conclusion as to the relative value of that drug. In Table 10 the type rates for the plain drug are compared with those for the two iodized preparations; Clinic II data only are used.

TABLE 10.—*Relation of complaint-type rates to total amount of drug given, comparing plain and iodized ethyl esters, Clinic II only.*

[Total complaint rates, per 100 cases in groups.]

Total amount.	Number of cases.		Type 1.		Type 2.	
	C. E.	C. E. I.	C. E.	C. E. I.	C. E.	C. E. I.
cc.						
10	169	164	5.3	13	55	9.8
20	243	270	2.5	13	80	8.9
30	123	205	3.3	16	53	9.8
More than 30	33	99	3.0	11	42	10

Total amount.	Type 3.		Type 4.		Type 5.	
	C. E.	C. E. I.	C. E.	C. E. I.	C. E.	C. E. I.
cc.						
10	40	39	84	116	36	40
20	36	30	51	69	14	23
30	35	26	35	30	8.1	13
More than 30	30	34	9.1	17	3.0	8.1

Type 1 rates show no regular or significant change with either preparation. Type 2, however, decreases with the plain but not with the iodized; indeed, with the latter it probably actually increases, as seen in Table 11. However, the rates are comparatively very low. Type 3 on the whole decreases somewhat more with the iodized than with the plain. The iodized preparations have a distinct disadvantage in types 4 and 5.

To compare the two iodized preparations the figures for both clinics can be used, which is more satisfactory, as the peculiarities of reports from one clinic tend to modify those from the other. These rates are given in Table 11.

Here type 1 decreases but slightly with the 2 per cent preparation, more so in the 0.5 per cent until the last group, which is surprisingly high. Type 2 increases with both, though not regularly; the rates are higher for the 2 per cent throughout. It is doubted whether less local irritation than is here indicated can be gotten with any preparation now available. Type 3 increases with the 2 per cent, and decreases with the 0.5 per cent, a point decidedly in favor of the latter. Types 4 and 5

decrease very similarly, but the figures for the 0.5 per cent are lower. Type 4 was reported more frequently for the iodized than for the plain from Clinic II (Table 10), and only slightly less frequently than the plain in the total figures (Table 5); here it is seen to be distinctly less frequent with the 0.5 per cent in the groups receiving the larger amounts, indicating that it can be given somewhat more intensively in patients susceptible to respiratory tract trouble. The advantage is with the 0.5 per cent iodized preparation in each instance, and in some it is marked.

TABLE 11.—*Relation of complaint-type rates to total amount of drug given, comparing 2 per cent and 0.5 per cent iodized preparations, both clinics.*

[Total complaint rates, per 100 cases in groups.]

Total amount.	Number of cases.		Type 1.		Type 2.	
	2 per cent.	0.5 per cent.	2 per cent.	0.5 per cent.	2 per cent.	0.5 per cent.
cc.						
To 10	217	191	12	6.8	16	7.9
11 to 20	431	378	11	5.8	15	9.0
21 to 30	279	288	11	4.5	15	12
More than 30	134	89	10	13	32	20

Total amount.	Type 3.		Type 4.		Type 5.	
	2 per cent.	0.5 per cent.	2 per cent.	0.5 per cent.	2 per cent.	0.5 per cent.
cc.						
To 10	17	36	81	55	49	33
11 to 20	23	17	43	44	24	24
21 to 30	19	17	25	20	15	11
More than 30	29	13	16	6.7	11	4.5

SUMMARY

To determine which preparation will permit the most intensive treatment with the fewest undesirable side-effects, the comparative frequency of complaints of patients under treatment with plain chaulmoogra ethyl esters and of those receiving 2 per cent and 0.5 per cent iodized preparations has been investigated. The 2 per cent iodized had been used at Culion extensively since late in 1921; but, as it was thought to have side-effects of its own, it was desired to compare a weaker concentration with it.

The 2,818 cases dealt with are distributed as follows: Plain drug, 809 cases, of which 240 were supposed to be injected twice

a week (Clinic I), and 569 once a week (Clinic II); 2 per cent iodized, 1,063 cases; and 0.5 per cent iodized, 946 cases; both of the latter were supposed to be injected but once a week, but many were given extra, interpolated injections. The distribution of these cases in the clinic units (Table 1), is irregular, but when the total cases of both clinics are considered the effect of this on the principal figures is not important.

In the matter of percentages of patients under each preparation for whom any complaint is recorded (Table 2), there is a decided lack of unanimity among the individual physicians, suggesting that neither preparation is very different from the others. However, the clinic averages, in which the individual variations are more or less neutralized, show that the plain drug caused the most patients to complain, and the 0.5 per cent iodized the least. The same is seen in the complaint rates. The plain drug has rather similar average percentages complaining in the two clinics, but the complaint rates are decidedly higher in Clinic I, in spite of the more favorable cases there, probably due largely to the more frequent injections.

The relative frequency of the principal individual symptoms with the different preparations is examined (Tables 3 and 4), and the matter summarized by the total figures for each symptom-group (Table 5). The plain drug has lower figures than the iodized for type 1 (immediate choking, etc.) and type 5 (lepra reactions), but in both instances the 0.5 per cent iodized is lower than the 2 per cent; indeed, as regards type 5 it is practically the same as with the plain. The iodized preparations, on the other hand, have lower rates for type 2 and for most of the complaints of type 3; as regards the former the 0.5 per cent is decidedly better than the 2 per cent. Chest oppression and pain occurred in practically the same percentage with all drugs, but a somewhat larger number complained of cough with the plain and the 2 per cent iodized than with the 0.5 per cent iodized. Taking these factors together, the balance is in favor of the iodized preparations as a whole, and decidedly best for the 0.5 per cent.

Little relation is seen between age and numbers of complaints with the plain drug, but with the others the figures decrease in both directions from maxima in the fourth decade, though there is a curious sharp rise in the oldest group with the 0.5 per cent iodized.

As regards the size of the dose given, the 0.5 per cent has an advantage in the larger percentages given doses larger than

3.5 cubic centimeters. The complaint figures of all, due to clinical control, decrease with increase of dosage, the larger doses having been given to patients who complained less. No preparation has a distinct advantage in this, but the 2 per cent iodized has a disadvantage in that the decrease is interrupted, the rate for the largest dose group being higher than that of the preceding one.

With the numbers of injections there is more contrast. In the complaint figures the decrease in the higher groups is far more marked relative to the maximum than is the case with dosage. The plain drug has by far the most cases receiving few injections, while the 0.5 per cent has a decided advantage over the 2 per cent. The 0.5 per cent iodized has decidedly the advantage in degree of decrease, while the 2 per cent not only has less relative decrease, but again shows a terminal increase, here in the two highest groups.

The total amounts of drug given naturally have similar variations. Small amounts were given to the fewest cases with the 0.5 per cent iodized, only 35 per cent of cases actually injected but once a week having received but 15 cubic centimeters or less, as compared with more than 50 per cent who were given the other preparations. The complaint figures with the 0.5 per cent have a greater relative decrease than those for either of the others and, unlike those for the 2 per cent, they do not increase in the largest-amount groups.

Analysis of the relation of the complaint types to amount of drug given shows differences between the preparations in only two types. As these were used, type 2 decreased with increase of total amount of the plain drug but increased with both iodized; the 0.5 per cent has, as usual, the lowest rates. Type 3 decreased with the 0.5 per cent, but increased with the 2 per cent.

From these findings it is very clear that the plain drug is the least suitable of the three preparations for use as the basic routine medication in antileprosy treatment. The advantage for the weaker iodized preparation in that larger percentages were given higher doses, more injections, and therefore greater amounts of drug, would be important even were the figures on complaints equal to those for the 2 per cent; that at the same time the complaint figures, both for numbers of patients complaining and for numbers of complaints, are distinctly less is a further point decidedly in its favor.

205355——4

It is pointed out that the higher complaint rates obtained with the plain and the 2 per cent iodized preparations on increasing the dose, etc., does not signify that this matter could not have been controlled, but that to do so would have required reducing the medication unduly in many cases. To obtain more therapeutic effect it was preferable to push the dosage, though the frequency of complaints was increased.

It may be remarked that information has recently been received[3] that, while at the outset a 4 per cent iodized preparation was used in Hawaii, this was soon reduced to 2 per cent and, more recently, to 1 per cent; use of the plain drug has practically been discontinued there. It was with some satisfaction that this corroboration of our main findings was received. While it cannot be positively asserted that the 0.5 per cent concentration is preferable to the 1 per cent, this seems quite likely. It has been seen (Table 5) that with type 1 complaints, of which the plain drug has least, the 0.5 per cent is better than the 2 per cent; that with type 5 the 2 per cent has the highest rate while the 0.5 per cent is practically the same as the plain; that with type 3 the two iodized are practically equal; and that the 0.5 per cent is the best with the important types 2 and 4. It would be surprising, indeed, if a stronger concentration of iodine would prove better.

CONCLUSIONS

The plain chaulmoogra ethyl esters are irritating, particularly to the tissues at the point of injection and to the respiratory tract, so much so as seriously to limit the intensiveness of treatment with it in a leper population such as that of the Culion colony.

Iodized preparations of the ethyl esters are much less irritating locally, which permits their more intensive use, and they also cause fewer complaints of general symptoms.

The 2 per cent iodized ethyl preparation, heretofore generally used, has, according to the data examined, certain minor but not insignificant disadvantages over the plain drug.

The 0.5 per cent iodized preparation is in several respects distinctly superior to the 2 per cent and, unlike this, in no important way compares disadvantageously with the plain drug. It is, therefore, the best of the three for routine antileprosy treatment.

[3] Hasseltine, H. E. Personal communication.

LAMPYRIDES ET TELEPHORIDES DES ILES PHILIPPINES

Par MAURICE PIC

Membre correspondant du Museum de Paris, Digoin (Saoûe et Loire), France

Les Malacodermes faisant l'objet du présent article appartiennent seulement aux groupes des Cantharides (ancien Telephorides) comprenant les Cantharini et les Malthinini aussi qu'an groupe des Lampyrides, ce dernier réduit à un petit nombre d'espèces; enfin, il est question ici d'une seule espèce de Drilides.

C'est grace aun interessantes communications de C. F. Baker que j'ai peu écrere le présent mémoire; aux espèces venant de Baker je n'ai presque rien ajouté personnellement, n'ayant obtenu précédemment que peu d'insectes de ces régions.

Aux espèces des Philippines je joins pour ne pas disperser trop les matériaux d'étude, provenant également des chasses de Baker, trois nouveautés originaires de Sandakan (Borneo) et une de Singapore, rentrant dans les Cantharides (Telephorides).

Ne sont par comprises dans ce mémoire quelques anciennes espèces de Malacodermes de l'île de Palawan, aucune espèce de cette ile ne m'ayant été communiquée par M. Baker.

LAMPYRIDES [1] ET DRILIDES

Les Lampyrides ayant été autrefois étudiés par feu mon ami E. Olivier, ce n'est que depuis sa mort que je me suis mis un peu à les travailler; actuellement je ne suis pas encore suffisamment documenté pour pousser a fond l'etude de cette famille, ma part contributive ici est donc restreinte et très incomplète.

Luciola abdominalis E. Oliv.

LUZON, Mount Banahao, No. 17140.

[1] Consulter pour les Lampyrides des Philippines, E. Olivier, in Baer "Coleópteres des Iles Philippines" Ann. Soc. Ent. Fr. (1886) 182 à 187.

Luciola bicoloriceps sp. nov.

Oblongo-elongata, nitida, explanata, flava, capite pro parte, antennis, tibiis pro parte tarsisque nigris.

Oblong-allongé, brillant, pubescent de gris, déprimé, nettement explané, flave avec la tête rousse, foncée postérieurement, antennes et majeura partie des tibias et tarses noirs. Tête creusée entre les yeux, modérément ponctuée; prothorax plus large que long, sinué antérieurement, presque droit sur les côtés, un peu rétrécé en avant, largement rebordé, sillonné au milieu, á ponctuation forte, rapprochée; écusson tronqué au sommet; élytres plus larges que le prothorax, non subparallèles, rétrécis a l'extrémité, à épaules arrondies, largement explanés, irréguliérement et assez finement ponctués, ciliés sur les côtés, pygidium échancré, dernier segment de l'abdomen subéchancré de chaque côté, postérieurement prolongé au milieu en un lobe court et large, tronqué au sommet.

Long. 7 mill.

MINDANAO, Iligan, No. 17137.

Ressemble un peu à *L. foveicollis* E. Ol. mais de coloration tout autre.

Colophotia praeusta Esch. et var.

La coloration noire est plus ou moins étendue à l'extrémité des élytres et le prothorax varie un peu de forme.

LUZON, Laguna Province, Los Baños, No. 17148. MINDANAO, Dapitan, No. 17147.

Colophotia brevis E. Ol. var. *a*.

Tête en partie flave.

MINDANAO, Bukidnon Province, Tangkulan, No. 17135.

Colophotia bakeri sp. nov.

Oblongo-elongata, nitida, flava, antennis tarsisque pro parte nigris.

Forme et coloration de *Luciola bicoloripes* Pic, sauf que la tête et les tibias (sauf parfois les antérieurs en partie obscurcis) sont flaves, mais de taille un peu plus grande avec la structure abdominale tout autre chez ♂. Le ♂ a les derniers segments abdominaux fortement entaillés et lobés, le dernier fortement entaillé au sommet, à côtés non épineux mais tronqués, le pygidium est profondement incisé; la ♀ a l'avant dernier segment ventral sinué au sommet et le dernier arqué au sommet.

Long. 9–10 mill.

MINDANAO, Surigao Province, Nos. 17136, 17139 ♀; 17138 ♂. A placer près de *C. concolor* E. Ol. très distinct par la structure abdominale du ♂.

Pyrophanes quadrimaculata E. Ol.

MINDANAO, Davao, No. 17146.

Ototreta bicoloripes sp. nov.

Oblongo-elongata, rufo-testacea, abdomine ad basin, antennis, tibiis tarsisque nigris, elytris nigris, diverse rufo-testaceo marginatis. Variat.: Elytris ad basin late rufo-testaceis (var. *basalis*); thorace in disco nigro notato et elytris ad basin et antice solum rufo notatis (var. *reducta*).

Oblong-allongé, peu brillant, finement pubescent, roux testacé avec la base de l'abdomen, les antennes, tibias et tarses noires; élytres noirs, diversement bordés de roux testacé chez forme type ou largement testacés à la base (var. *basalis*). Parfois le prothorax est plus ou moins maculé de foncé sur le disque, tendés que la bordure claire des élytres s'oblitere plus ou moins jusqu'à la base qui tout au moins reste claire (var. *reducta*). Tête large; antennes assez comprimeés; prothorax court, sillonné, à angles postérieurs un peu avancés, modérément ponctué; ecusson testacé ou plus ou moins foncé; élytres pas trés larges, subparallèles, densément ponctués.

Long. 5–6 mill.

MINDANAO, Butuan, Nos. 17149, 17160, 17150, 17153. Voisin de *O. debilis* E. Ol. distinct, à première vue, par la tête non foncée.

Ototreta subtilis E. Ol. var. **vittiger** E. Ol.

Ototreta subtilis est variable quant à la coloration du prothorax et des membres, mais la tête parait toujours foncée.

MINDANAO, Butuan et Surigao, Nos. 17156, 17157.

Ototreta bakeri Pic.

LUZON, Mount Maquiling. MINDANAO, Butuan, No. 17151.

Dodecatoma testaceiceps sp. nov.

Parum nitida, testacea, antennis, articulis 2 basalibus exceptis, oculis abdomineque supra pro parte nigris, elytris brevibus, valde dehiscentibus, testaceis, apice late piceis.

Un peu brillant, courtement pubescent de flave-testacé avec partie du dessus de l'abdomen, yeux et antennes, moins les 2 premiers articles noirs, élytres largement foncés à l'extrémité,

ces organes courts, dehiscents des la base, très fortement et ruguleusement ponctués postérieurement, presque mats. Tête assez petite, antennes robustes à article 3 allongé, 4 et 5 fortement dentés, suivants courts et subpectinés; prothorax court et trés large, subarqué sur les côtés, sillonné au milieu et fortement impressionné de chaque côté de la base, distinctement, mais non densément ponctué; écusson grand, tronqué au sommet, ponctué; élytres de la largeur du prothorax à la base, très acuminés postérieurement trés débordés par l'abdomen et les ailes; pattes assez robustes.

Long. 7 mill.

LUZON, Mount Maquiling, No. 17152.

Espèce distingue, à première vue, de *D. bicolor* Westh. par la tête testacée et les antennes plus robustes.

CANTHARIDES (TELEPHORIDES)

Les espèces rentrant dans les deux genres *Cantharis* L. et *Discodon* Gorh., originaires du Iles Philippines, se distingueront plus facilement a l'aide du synopsis suivant. Je dois faire observer que les espèces de Cantharides ne sont pas toujours surement classables au point de vue générique, à causes de la structure tarsale différente parfois suivant les sexes et aussi parceque l'on étudie quelque fois des insectes plus ou moins mutilés.

Je ne connais pas en nature *C. flavifemoralis* Blanch., décrit de l'ile de Mindanao, à moins que ce soit (ce qui est fort possible) la même espèce que *Tylocerus atricornis* Guer., dont il est question plus loin.

Le *C. philippinensis* Pic décrit sur un exemplaire de ma collection pas en très bon état de conservation, se distingue des espèces figurant dans le synopsis suivant par ses élytres franchement et complètement noirs, non granuleux et sans poils dressés et la tête, avec les yeux très gros, plus large que le prothorax.

Cantharis vanikorensis Boisd.

BASILAN. MINDANAO, Kolumbugan, No. 6677.

Cantharis granulipennis Boh.

LUZON, Benguet Subprovince, Baguio, No. 6680.

Discodon baguionum sp. nov.

Elongatum, nitidum, elytris subopacis, valde pubescentibus, pallido-testaceum, pro parte brunneum, capite postice elytrisque apice breve nigris.

Allongé, brillant avec les élytres densément pubescents de gris, ornés de quelques poils soulevés et presque mats, testacé-pâle rembruni par places, tête, sauf en avant, et sommet du élytres brièvement noirs. Tête pas trés large; antennes rembrunies, à base rousse, parfois foncées; prothorax court et peu large, arqué en avant; bimaculé de brun sur le disque postérieurement; élytres peu plus larges que le prothorax, longs, finement et densément ponctués; dessous du corps en partie roux, en partie rembruni; pattes grêles, testacées avec les tarses en partie rembrunis, parfois pattes noires avec la base descuisses largement testacée, un des ongles des tarses fendu chez ♂.

Long. 9–10 mill.

LUZON, Benguet Subprovince, Baguio, No. 8266.

Par sa coloration parait se rapprocher de *C. flavifemoralis* Blanch., que je ne connais pas en nature, mais les élytres sont moins largement noirs au sommet, la forme est plus gracile, la tête est en partie noire, etc.

Discodon tangkulanum sp. nov.

Elongatum, nitidum, parum pubescente et hirsutum, rufum, capite tarsisque nigris, elytris cyaneis.

Allongé, brillant, peu pubescent de gris et hérissé de poils obscurs sur les élytres, roux avec la tête et les tarses noirs, les élytres bleus. Tête assez large; prothorax court et large, subarqué en avant; élytres pas plus larges que le prothorax, assez longs, sinués latéralement, en partie granuleux; pattes robustes, tibias aplatis, un ongle des tarses fendu.

Long. 10 mill.

MINDANAO, Bukidnon Province, Tangkulan, No. 16162.

Peut se placer près de *D. fruhstorferi* Pic, très distinct par ses élytres bleu-violacés, le prothorax roux et plus robuste, les pattes plus fortes.

Discodon mindanaonum sp. nov.

Elongatum, nitidum, elytris subopacis, parum pubescentibus, rufo-testaceum, antennis late, tarsis elytrisque nigris, his ad basin paulo rufo-testaceo notatis.

Allongé, brillant avec les élytres subopaques, pubescent de jaune sans poils dressés, roux-testacé avec les antennes, sauf le dernier article, les tarses et les élytres noirs, ces derniers brièvement marqués de roux-testacé à la base. Tête grosse; antennes dentées, noires, dernier article roux; prothorax court et large, arqué en avant, puis impressionné de chaque côté; élytres peu plus larges que le prothorax, assez longs, densément

ponctués et un peu ruguleux avec des traces de côtés discales; pattes robustes, tibias en partie arqués, testacés avec les tarses noirs, parfois avec les genoux et partie des tibias foncés, un ongle des tarses en partie longuement dente, au moins chez ♂.

Long. 9–13 mill.

MINDANAO, Tangkulan, Iligan, et Surigao, Nos. 11164, 11165.

Peut se placer près de *D. martapuranum* Pic, un peu plus robuste avec les antennes plus foncées et de structure différente.

Discodon atrocyaneum sp. nov.

Oblongo-elongatum, nitidum, elytris holosericeo pubescentibus, nigrum, thorace, scutello, abdomine pro parte, coxis femoribusque ad basin testaceis, elytris atrocyaneis.

Oblong-allongé, brillant, élytres revelus d'une pubescence grise soyeuse, noir, prothorax, écusson, parties de l'abdomen hanches et base des femurs, testacés, élytres d'un bleu d'acier. Tête large, antennes grêles, filiformes; prothorax court, un peu rétrécé en avant, subarqué antérieurement, roux-testacé, brièvement rembruni sur son milieu antérieur; élytres peu plus larges que le prothorax, relativement courts, sinués sur les côtés; finement et densément ponctués, pattes assez grêles, tibias en partie arqués.

Long. 7 mill.

Une ♀ de ma collection originaire de Mindanao.

Voisin de *D. tokianum* Pic, moins allongé avec les élytres non bordés de flave et à reflets bleus, les pattes bicolores.

Discodon surigaonum sp. nov.

Satis ♂, aut parum ♀, elongatum, nitidum, nigrum, thorace, scutello abdomine pro parte, coxis femoribusque ad basin testaceis.

Un peu ♂, ou à peine ♀, allongé, brillant avec les élytres à pubescence soyeuse, noir, prothorax, écusson, partie de l'abdomen, hanches et base des femurs testacés. Tête plus ou moins large suivant les sexes, noire, parfois un peu roussâtre en avant; antennes un peu robustes, noires, d'ordinaire avec le dernier article roussâtre a l'extrémité; prothorax court et large, presque droit sur les côtés ♂, un peu rétrécé en avant ♀; élytres à peine plus larges que le prothorax, relativement courts, finement et en partie ruguleusement ponctués; pattes assez grêles, un ongle des tarses fendu chez ♂.

Une variété ♀ a le prothorax maculé de noir en avant.

Long. 6–7 mill.

MINDANAO, Surigao, No. 17209.

Voisin du precédent et distinct, à premiére vue, par les élytres franchement noirs.

Discodon luzonicum sp. nov.

Elongatum, parum nitidum, testaceum, antennis, pedibus pro majore parte elytrisque nigris, his ad basin testaceo maculatis.

Allongé, peu brillant, à pubescence couchée grise ou jaune, testacé avec les antennes, moins le dernier article roux, les pattes moins les femurs largement testacés à la base et les élytres noirs, ces derniers ornés d'une macule basale testacée pas très grande. Tête grosse, antennes dentées; prothorax court et large, trés arqué en avant, impressionné sur les côtés et sillonné sur le disque; élytres à peine plus larges que le prothorax, longs, subparalleles, finement ponctués et en partie ruguleux dessous du corps testacé, abdomen rembruni; pattes assez grêles, ongles en partie dentés.

Long. 10 mill.

LUZON, Mount Maquiling.

Ressemble à *D. mindanaonum* sp. nov., plus haut, quant à sa forme mais le prothorax est plus arqué en avant et les élytres sont nettement marqués de testacé à la base.

Discodon sandakanum sp. nov.

Elongatum, nitidum, rufo-testaceum, oculis elytrisque lateraliter et apice nigris.

Allongé, brillant, modérément et finement pubescent de gris, roux-testacé avec les yeux noirs, les élytres étant ornés d'une bande longitudinale externe qui ne touche pas antérieurement le bord latéral et se prolonge étroitement au sommet. Tête grosse avec les yeux débordant le prothorax; antennes grêles, à articles médians subdentés; prothorax relativement long, arqué en avant, nettement sinué sur les côtés, impressionné sur son milieu postérieurement et sur les côtés; élytres un peu plus larges que le prothorax, assez longs, faiblement élargis postérieurement, à ponctuation fine et dense; pattes un peu robustes, tibias arqués.

Long. 8 mill.

BORNEO, Sandakan, No. 17184.

Ressemble par sa forme a *D. siobanum* Pic dont il différe nettement, en plus de la coloration très différente des élytres, par ces organes plus courts et plus brillant, ainsi que par la tête plus grosse.

Synopsis des espèces des genres Discodon et Cantharis.

1. Elytres entiérement, ou largement, foncés; prothorax entiérement testacé, ou roux, parfois seulement marqué de foncé au milieu antérieurement .... 2.
   Elytres testacé-pâle, brièvement noirs au sommet; prothorax pâle, bimaculé de noir .... **Discodon baguionum** sp. nov.
2. Elytres entiérement foncés, ou brièvement marqués de roux à la base.... 3.
   Elytres verts, largement testacés a l'extrémité, ongles sinués. **Cantharis vanikorensis** Boisd.
3. Antennes noires, parfois à dernier article roux ou testacé, élytres variables et ongles des tarses aussi .... 4.
   Antennes testacées; élytres bleu métallique brillants, un ongle des tarses fendu .... **Discodon tangkulanum** sp. nov.
4. Elytres plus ou moins brillants, noirs, parfois à peine bleu d'acier, concolores ou non .... 5.
   Elytres mats, d'un noir verdâtre (parfois violacés, ex Boheman). Tête noire, ongles des tarses simples .... **Cantharis granulipennis** Boh.
5. Tête testacée; élytres diversement marqués de roux à la base .... 7.
   Tête foncée; élytres entièrement foncés; taille plus petite .... 6.
6. Elytres à reflets d'acier; prothorax paraissant plus large. **Discodon atrocyaneum** sp. nov.
   Elytres franchement noirs; prothorax moins large, au moins ♂. **Discodon surigaonum** sp. nov.
7. Elytres noirs, brièvement marqués de roux à l'extrême base; majeure partie des pattes testacée .... **Discodon mindanaonum** sp. nov.
   Elytres noirs, à base ocrée; majeure partie des pattes noire, cuisses testacées à la base .... **Discodon luzonicum** sp. nov.

Tylocerus atricornis Guer.

Espèce décrite de Manille et que je possède de Basilan (ex Doherty) et de Manille (ex Baer).

La variété nouvelle *cumingi* Pic a les pattes testacées avec les genoux et les tarses seulement foncés. Je la possède des Iles Philippines, sans autre indication de provenance, par la collection Gorham.

Tylocerus mindanaonis sp. nov.

Oblongo-elongatus, fere opacus, testaceus, antennis, capite postice ♂ pedibusque pro majore parte nigris, elytris nigris, dense griseo pubescentibus, lateraliter aliquot ad suturam, flavo marginatis.

Oblong-allongé, presque mat, testacé avec les antennes et les pattes, moins la majeure partie des cuisses, noires, élytres d'un noir gris, à pubescence soyeuse, au moins en partie bordés de flave. Tête testacée, parfois foncée sur le vertex; antennes différentes suivant les sexes, plus longues chez ♂ avec le 1^er^ article grand et épais, toutes noires ou avec le 1^er^ article taché de

roux; prothorax court et transversal, surtout chez ♀ ; élytres de la largeur du prothorax, un peu élargis au milieu, finement et densément ponctués; pattes robustes, noires avec les cuisses largement testacées, parfois tibias bicolores; ceux-ci en partie et finement epineux.

Long. 10–11 mill.

MINDANAO, Surigao, Nos. 16166, 16167, 7256, 6681.

Voisin de *T. atricornis* Guer. distinct, à première vue, par sa coloration élytrale.

Tylocerus convexithorax sp. nov.

Oblongo-elongatus, fere opacus, testaceus, antennis pro majore parte oculisque nigris, elytris nigro-piceis, testaceo cinctis et ad basin testaceo maculatis.

Oblong-allongé, presque opaque en dessus, à pubescence, en partie soulevée, grise ou foncée, testacé avec les yeux et antennes noires, ces dernières avec les 2 premiers articles testacés, celles-ci grêles et poilues, à premier article peu gros, arqué, élytres d'un noir de poix, à base et pourtour testacés. Tête petite, fortement creusée entre les yeux; prothorax particulier, convexe, densément et ruguleusement ponctué sur le disque, largement explané sur les côtés qui sont nettement arqués, prolongé subtriangulairement sur le milieu antérieur, sinué postérieurement, étroitement rebordé en avant et en arriére; élytres pas plus larges que le prothorax, courts, courtement rétrécé a l'extrémité, nettement explanés, densément et en partie ruguleusement ponctués avec des vestiges de côtés sur le disque; pattes assez robustes ♀.

Long. 7 mill.

MINDANAO, Surigao, No. 17203.

Espèce à faciès de *Luciola*, distincte entre toutes par sa forme et la structure de son prothorax.

Tylocerus sericeus Pic.

LUZON, Benguet Subprovince, Baguio. MINDANAO, Zamboanga Province, Dapitan, Nos. 17196, 17207, 6045.

Tylocerus bakeri sp. nov.

Elongatus, nitidus, niger, thorace pro parte coxisque testaceis, elytris diverse albo notatis, rare innotatis, abdomine albo marginato. Variat.: thorace testaceo, concolore (var. *obliteratus*.)

Allongé, brillant, à pubescence soyeuse avec les élytres un peu granuleux et hérissés, noir avec les élytres d'ordinaire

marqués de flave sur le disque, ou sur les côtés médians, parfois concolores, prothorax testacé, maculé diversement de foncé sur le disque et en avant (forme type), parfois concolore, testacé (var. *obliteratus*), hanches et parfois la base des cuisses testacées, abdomen foncé, diversement marginé de flave. Tête grande ♂, ou petite ♀; antennes plus longues chez ♂ que ♀, grêles avec le premier article épais ♂, noires, sommet du dernier article roussâtre; prothorax court et modérément large, un peu élargi postérieurement; élytres pas plus larges que le prothorax, sinués sur les côtés, assez longs, parfois plus brillants et plus foncés chez ♀; pattes grêles ♀, ou à tibias un peu aplatés et creusés ♂.

Long. 6–10 mill.

MINDANAO, Bukidnon Province, Tangkulan. LUZON, Mount Maquiling, Mount Banahao, Los Baños, Nos. 154, 1732, 2820. Aussi à Borneo, Sandakan, No. 17192.

Très distinct de *T. sericeus* Pic, par sa forme plus allongée et sa coloration.

Tylocerus discovittatus sp. nov.

Elongatus, nitidus, niger, thorace, illo antice nigro notato, membris et abdomine, pro parte rufis, elytris in disco luteo vittatis.

Allongé, brillant, orné d'une pubescence grise en partie soulevée, noir, base des antennes, partie des pattes et du dessous du corps roux, prothorax roux-testacé, maculé de foncé sur son milieu antérieur; élytres noirs, à reflets un peu métalliques avec une bande discale jaune élargie postérieurement et éloignée des extrémités. Tête plus étroite que le prothorax; antennes grêles; prothorax court et large, élargi postérieurement; élytres à peine plus larges que le prothorax, peu longs, sinués sur les côtés, finement et densément ponctué; pattes robustes, presque entièrement noires; abdomen foncé, marginé de flave ♀.

Long. 7 mill.

MINDANAO, Bukidnon Province, Tangkulan, No. 17198.

Très distinct du précédent et des suivants par sa coloration élytrale particulière.

Tylocerus invittatus sp. nov.

Oblongo-elongatus, nitidus, niger, thorace circa, femoribus ad basin abdomineque pro parte testaceis, elytris nigris, ad humeros et lateraliter testaceis.

Oblong-allongé, brillant, orné d'une pubescence grise en partie soulevée, noir avec le pourtour du prothorax et de l'abdomen,

la base des cuisses, le calus huméral et les côtés des élytres testacés. Tête robuste, antennes grêles, à premier article épais; prothorax en carré transversal, nettement marginé-relevé sur le pourtour; élytres pas plus larges que le prothorax, assez courts, sinués latéralement, finement et densément ponctués; pattes assez grêles ♂.

Long. 6 mill.

MINDANAO, Zamboanga Province, Dapitan, No. 17197.

Voisin de *T. distinctipennis* Pic, en diffère, en plus de la coloration, par le prothorax non subangulé postérieurement sur les côtés et le 1er article des antennes plus èpais.

Tylocerus vittigerus sp. nov.

Oblongo-elongatus, nitidus, niger, thorace circa, femoribus ad basin abdomineque pro parte testaceis; elytris nigris, in disco lateraliter medio et apice luteo-testaceo notatis.

Oblong-allongé, brillant, orné d'une fine pubescence grise, noir, parfois à reflets un peu métalliques par places, pourtour du prothorax, partie de l'abdomen et base des cuisses testacés, élytres à bande discale obliterée postérieurement, bord latéral median et sommet d'un jaune testacé. Tête assez robuste, antennes grêles, a 1er article épais, taché de testacé à la base; prothorax en carré transversal, nettement marginé-relevé sur le pourtour; élytres pas plus larges que le prothorax, assez courts, sinués latéralement; finement et densément ponctués; pattes assez grêles, ♂.

Long. 7 mill.

LUZON, Benguet Province, Baguio, No. 17193.

Voisin du précédent, s'en distingue, à première vue, par la bande claire discale des élytres.

Synopsis des espèces de Tylocerus.

1. Prothorax non bombé sur le disque et brillant; élytres à pubescence soyeuse; pattes plus ou moins foncéees........ 2.
   Prothorax bombé sur le disque et mat; élytres sans reflets soyeux; pattes testacées, robustes........ **T. convexithorax** sp. nov.
2. Premier article des antennes ♂ moins long, ou moins épais; moyennes ou petites espèces; prothorax non entièrement testacé, d'ordinaire largement noir........ 4.
   Premier article des antennes ♂ long et épais; assez grandes espèces; prothorax entièrement testacé........ 3.
3. Elytres foncés, plus ou moins bordés de flave..... **T. mindanaonus** sp. nov.
   Elytres testacés, maculés de noir au sommet. Pattes plus ou moins foncées avec la base des cuisses testacée (forme type), ou testacées avec les genoux et tarses foncés (var. *cumingi* Pic).
   T. atricornis Guer.

4. Prothorax bicolore, noir et testacé; élytres d'ordinaire marqués de flave ou de testacé............ 5.
   Prothorax entièrement foncé ainsi que les élytres et le reste du corps. **T. sericeus** Pic.
5. Prothorax noir, bordé de clair; élytres longuement bordés de clair...... 7.
   Prothorax testacé, plus ou moins marqué de noir sur son milieu antérieurement, rarement presque concolore, testacé; élytres non bordés, ou seulement brièvement clairs sur le milieu des côtés............ 6.
6. Elytres noirs, brièvement marqués de flave (et diversement) sur le milieu discal; des poils dressés nets. Parfois la macule flave s'oblitère ♀............ **T. bakeri** sp. nov.
   Elytres noirs à reflets métalliques, à longue bande discale testacé-jaunâtre un peu dilatée postérieurement, eloignée des extrémités; pas de poils dressés nets............ **T. discovittatus** sp. nov.
7. Elytres sans bande discale testacée; épaules tachées de clair (par l'élargissement de la bordure claire)............ **T. invittatus** sp. nov.
   Elytres avec une bande discale testacée; épaules noires. **T. vittigerus** sp. nov.

Polemiosilis semibrunnescens sp. nov.

Parum elongatus, nitidus, rufo-testaceus, membris elytrisque pro parte brunnescentibus.

Peu allongé, brillant, orné d'une pubescence grise avec quelques poils courts, relevés, roux-testacé avec partie des membres et élytres en majeure partie rembrunis. Tête grosse avec les yeux, qui sont noirs, plus large que le prothorax; antennes assez épaisses, à articles médians un peu échancrés et subdentés au sommet, foncées avec la base rousse; prothorax peu large, arqué en avant, peu rétréci en arrière; élytres nettement plus larges que le prothorax, peu longs, subsinués latéralement, peu densément ponctués, en partie ruguleux, ces organes sont roux à la base, rembrunis sur le disque avec l'extrémité plus foncée; dessous du corps testacé avec l'abdomen en partie rembruni, assez courtement bilobé au sommet; pattes testacées, tachées de brun, un peu robustes, ongles non fendus.

Long. 8 mill.

Singapore, No. 17190.

Voisin de *P. testaceicollis* Pic, de la même provenance, s'en distingue, à première vue, par les antennes non robustes et la coloration.

Polemiosilis piceolateralis sp. nov.

Paulo elongatus, subparallelus, nitidus, rufo-testaceus, antennis pedibusque por parte piceis, elytris lateraliter piceo lineatis.

Un peu allongé, subparallèle, brillant, orné d'une pubescence grise en partie soulevée, roux-testacé avec parties des membres et élytres latéralement couleur de poix. Tête grosse avec les

yeux, qui sont noirs, plus larges que le prothorax; antennes peu robustes, à articles intermédiaires un peu élargis et dentés au sommet; foncées avec la base et le dernier article testacés; prothorax court et assez large, arqué en avant, presque droit sur les côtés postérieurs; élytres peu plus larges que le prothorax, pas três longs, presque parallèles, densément ponctués et en partie ruguleux, testacés avec une bande longitudinale externe couleur de poix, plus large postérieurement; dessous du corps roux-testacé, abdomen, au sommet, courtement bilobé; pattes brun de poix avec les tibias variablement testacés et les cuisses largement testacées à la base, peu robustes, ongles non fendus.

Long. 7 mill.

LUZON, Laguna Province, Mount Maquiling, No. 152.

Voisin du précédent, s'en distingue, en plus de la coloration diffèrente des élytres, par les antennes moins grêles, et le prothorax plus transversal.

Polemiosilis forticornis sp. nov.

Parum elongatus, nitidus, niger, capite, thorace scutello elytrisque rufis.

Peu allongé, brillant orné d'une pubescence grise en partie soulevée parfois avec quelques petits poils dressés, noir avec le dessus du corps roux. Tète non ♀, ou plus large que le prothorax; antennes robustes, plus ou moins aplaties, plus longues chez ♂ que chez ♀, noires, parfois rousses à l'extrême base, à dernier article roux au sommet; prothorax un peu transversal chez ♀, moins large ♂, arqué en avant, peu rétrécé en arrière; élytres à peine plus larges que le prothorax, assez longs, subsinués latéralement, à ponctuation en partie ruguleuse rapprochée et parfois des traces de costules sur le disque, dessous du corps foncé, abdomen parfois marqué brièvement de roux, lobes latéraux de l'extrémité de l'abdomen ♂ subtriangulaires; pattes noires, parfois marquées de roux à la base des cuisses, assez robustes, ongles non fendus.

Long. 8–10 mill.

MINDANAO, Agusan Province, Butuan, Nos. 17170, 17172, 17168, 17173.

Très distinct des espèces précédentes par les antennes plus fortes, aplaties et les élytres concolores.

Polemiosilis proximus sp. nov.

Parum elongatus, nitidus, niger, capite, antennis apice, thorace, scutello elytris femoribusque ad basin rufis.

Peu allongé, brillant, orné d'une pubescence grise en partie soulevée, avec quelques petits poils dressés, noir avec le dessus du corps et la base des cuisses plus ou moins roux, antennes noires à dernier article ♀, ou deux derniers ♀, testacés, lobes latéraux de l'extrémité de l'abdomen, chez ♂, arrondis.

Long. 8–9 mill.

MINDANAO, Agusan Province, Butuan, Nos. 17169, 17178.

Ressemble au précédent par la forme et la coloration, en diffère par la coloration plus claire de l'extrémité des antennes et la structure abdominale du ♂.

Synopsis des espèces de Polemiosilis.

1. Elytres entièrement testacés, ou en partie rembrunis .... 2.
   Elytres entièrement noirs. (Singapore.) .... **P. testaceicollis** Pic.
2. Elytres entièrement testacés .... 4.
   Elytres marqués de brun .... 3.
3. Elytres largement rembrunis sur le disque. (Singapore.)
   P. semibrunnescens sp. nov.
   Elytres ayant seulement une bande latérale brune.
   P. piceolateralis sp. nov.
4. Lobes latéraux de l'extrémité de l'abdomen ♂ subtriangulaires; dernier article des antennes tout noir, ou un peu roux au sommet.
   P. forticornis sp. nov.
   Lobes latéraux de l'extrémité de l'abdomen ♂ arrondis; deux derniers articles des antennes ♂ et dernier ♀ testacés .... **P. proximus** sp. nov.

Le synopsis ci-dessus, avec les espèces des Iles Philippines, comprend 2 espèces de Singapore des chasses de Baker.

Allocotomosilis inapicalis sp. nov.

Parum elongatus, parum nitidus, rufo-testaceus, membris pro parte brunneo piceis, pro parte rufis, antennis ad basin depressis, apice gracilibus, articulis 7–8 difformibus.

Peu allongé, un peu brillant, pubescent de jaune, la pubescence en partie soulevée sur les élytres, roux testacé, membres en partie roux-testacé, en partie brun de poix. Tête assez grosse, yeux noirs, trés saillants; antennes robustes à la base, à articles 3 à 6 déprimés, 6ᵉ creusé en dessus, 4 derniers grêles, 7ᵉ article plus clair, incurvé et muni de deux lobes dont un plus court et un peu crochus, 8ᵉ article un peu creusé et bidenté en dedans; prothorax court et large, sinué latéralement, un peu échancré près de la base, angles antérieurs saillants en dehors; élytres à peine plus larges que le prothorax, pas très longs, subparallèles, à ponctuation ruguleuse, dense; pattes grêles, foncées avec la

base des cuisses testacé; dessous du corps testacé avec l'abdomen en partie foncé et en forme de trident au sommet ♂.

Long. 8 mill.

BORNEO, Sandakan, No. 17181.

Diffère de *A. depressicornis* Pic par les élytres concolores et la conformation un peu differente du 7e article des antennes.

Silis particularicornis sp. nov.

Parum elongatus, nitidus, testaceus, elytris apice nigris, antennis pro parte brunneis, articulis 4 et 5 dilatatis, subglobulosis, 7° elongato, longe impresso.

Peu allongé, brillant, pubescent de gris, la pubescence étant en partie soulevée sur les élytres, testacé, un peu roussâtre par places, avec les yeux et le sommet des élytres brièvement noirs, les antennes rembrunies sur leur milieu et plus claires à l'extrémité qu'à la base. Tête assez grosse; antennes particulières, à 1er article long et épais, 2e mince et court, 4 et 5 épaissés et subglobuleux, suivants longs avec les 6 à 8 un peu plus épais que les derniers, le 8e étant longuement impressionné au sommet en dessus; prothorax court et large, dilaté vers le milieu, un peu entaillé postérieurement, à angles antérieurs et postérieurs saillants près d'une petite échancrure; élytres à peine plus larges que le prothorax, pas trés longs, subparallèles, à ponctuation ruguleuse dense; pattes assez grêles, testacées, tibias antérieurs en partie, tarses antérieurs et genoux rembrunis.

Long. 8 mill.

BORNEO, Sandakan, No. 17179.

Peut se placer prés de *S. notaticornis* Pic, trés distinct par la structure de ses antennes.

Silis cordicollis sp. nov.

Elongatus, nitidus, testaceus, oculis nigris, antennisque pro parte brunneis.

Allongé, brillant, orné d'une pubescence grise en partie soulevée, testacé avec les yeux noirs et les antennes brunes avec les premiers et les derniers articles testacés. Tête grande, avec les yeux, plus large que le prothorax; antennes longues et assez grêles; prothorax particulier, plus long que large, un peu cordiforme, fortement élargi et subarrondi antérieurement, arqué en avant, rétrécé-étranglé postérieurement avec les angles postérieurs trés saillants, orné d'une forte impression de chaque côté antérieurement et d'une autre médiane sur la base; élytres

bien plus larges que le prothorax, longs, subparallèles, médiocrement et en partie ruguleusement ponctués; pattes longues et grêles, un ongle des tarses fendu; abdomen entaillé-lobé au sommet et muni d'un crochet médian.

Long. 10 mill.

MINDANAO, Surigao, No. 17175.

Espèce distincte entre toutes par la structure de son prothorax.

Silis minimus sp. nov.

Elongatus, subparallelus, nitidus, testaceus, oculis et antennis ad medium late nigris.

Allongé, subparallèle, brillant, pubescent de jaune, la pubescence étant en partie soulevée, testacé, yeux et milieu des antennes largement noirs. Tête large; antennes grêles, poilues; prothorax court et large, sinué sur les côtés, non rétrécé en avant; élytres à peine plus larges que le prothorax, assez longs, subparallèles, à ponctuation dense en partie ruguleuse; pattes assez grêles.

Long. 4.5–5 mill.

BASILAN. MINDANAO, Surigao, Nos. 17176, 17177. Peut se placer près de *S. subrecticollis* Pic, distinct, à première vue, par les antennes en partie foncées, le prothorax plus droit sur les côtés, etc.

Silis bakeri sp. nov.

Elongatus, subparallelus, nitidus, rufo-testaceus, oculis, antennisque nigris, his ad basin rufis.

Allongé, subparallèle, brillant, pubescent de jaune, la pubescence étant en partie soulevée, roux testacé avec les yeux et les antennes, moins leur base, noirs. Tête large; antennes grêles, poilues; prothorax court, pas très large, subarqué en avant, nettement élargi en avant chez ♂, ou muni d'un pli antérieur ♀; élytres un peu plus larges que le prothorax, assez longs, subparallèles, à ponctuation pas très dense et en partie ruguleuse; pattes assez grêles.

Long. 6 mill.

MINDANAO, Surigao, Nos. 17187, 17188.

Très distinct du précédent par la forme de son prothorax, qui le rapproche des suivants, ainsi que par la coloration des antennes.

J'attribue à cette espèce, comme variété, sous le nom de var. *breveapicalis,* deux exemplaires à coloration générale du dessus plus claire, avec les élytres flaves, brièvement marqués de foncé à l'extrémité; ils proviennent du Mont Banahao.

Silis bukidnonus sp. nov.

Elongatus, nitidus, oculis, antennis, articulo 1° rufo excepto, abdomine pro parte, tarsis et elytris apice late nigris.

Allongé, brillant, orné d'une pubescence grise en partie soulevée, roux-testacé avec les yeux, les antennes moins leur base, les tarses, partie de l'abdomen et partie postérieure des élytres noirs. Tête large; antennes grêles et poilues; prothorax court et large, nettement élargi en avant ♂, ou muni d'un pli antérieur ♀ ; élytres un peu plus larges que le prothorax, assez longs, subparellèles, à ponctuation pas trés dense, en partie ruguleuse; pattes assez grêles.

Long. 7–8 mill.

La var. *banahaonus*, du Mont Banahao, a les élytres de coloration générale foncée, ou brièvement roux à la base.

MINDANAO, Bukidnon Province, Tangkulan: Cotabato Province, Kolumbugan, Nos. 17206, 17205, 17204.

Voisin du précédent avec les élytres largement, ou presque complètement, foncés.

Silis dilaticollis sp. nov.

Elongatus, nitidus, testaceus, oculis, antennis, pedibus pro majore parte, infra corpore pro parte elytrisque nigris, his ad basin parum late testaceo-notatis.

Allongé, brillant, pubescent de gris avec des poils redressés, testacé avec les yeux, les antennes, les pattes, moins une partie des cuisses, le dessous du corps en partie et les élytres noirs, à base peu largement maculée de testacé. Tête large, antennes un peu robustes; prothorax court, fortement dilaté subanguleusement en avant ♂, impressionné au milieu; élytres un peu plus larges que le prothorax, assez courts, à ponctuation peu distincte, en partie ruguleux; pattes pas très grêles.

Long. 6 mill.

LUZON, Mount Maquiling, No. 2399.

Distinct, à premiére vue, de l'espèce précédente par la structure de son prothorax qui chez ♂ est bien plus élargi en avant.

Aux espèces des Iles Philippines j'ajoute, dans le synopsis suivant une espèce nouvelle, originaire de Borneo, découverte par Baker.

Synopsis des espèces de Silis.

1. Prothorax relativement court ou large; élytres moins longs................. 2.
   Prothorax plus long que large, fortement élargi en avant; élytres très longs.. **S. cordicollis** sp. nov.

2. Prothorax plus ou moins fortement dilaté-élargi en avant ♂, ou muni antérieurement d'un repli saillant ♀; antennes plus ou moins foncées, à base parfois rousse .... 4.
   Prothorax non élargi en avant, incisé au milieu, ou postérieurement, chez ♂; antennes testacées, rembrunies ou noires au milieu .... 3.
3. Assez grande espèce à élytres brièvement noirs au sommet; antennes robustes, tricolores, roussâtres à la base, testacées à l'extrémité avec les articles 5–6 rembrunis. (Borneo.) .... **S. particularicornis** sp. nov.
   Petite espèce à élytres concolores, testacés; antennes assez grêles, largement noires au milieu .... **S. minimus** sp. nov.
4. Elytres plus ou moins foncés, tout au moins foncés a leur extrémité .... 5.
   Elytres concolores, entièrement testacés .... **S. bakeri** sp. nov.
5. Elytres presque entièrement foncés, au moins largement foncé à leur extrémité .... 6.
   Elytres d'un testacé pâle, à sommet brièvement foncé.
   S. b. var. **breveapicalis** var nov.
6. Prothorax peu fortement dilaté en avant ♂ .... 7.
   Prothorax très fortement dilaté en avant ♂ .... **S. dilaticollis** sp. nov.
7. Elytres largement marqués de roux-testacé à la base.
   S. bukidnonus sp. nov.
   Elytres foncés, a peine marqués de roux à la base.
   S. b. var. **banahaonus** var. nov.

Drilosilis robusticornis sp. nov.

Parum elongatus, nitidus, niger, antennis, capite antice, thorace diverse, abdomine pro parte rufo-testaceis, elytris ad suturam testaceo notatis.

Peu allongé, brillant, peu et finement pubescent; noir, devant de la tête, antennes, prothorax en partie et abdomen en partie roux-testacés, milieu des élytres marqués de testacé sur la suture. Tête large; antennes robustes, largement et courtement flabellées; prothorax roux, noir au milieu ou en avant, court et large, étranglé sur la base, lobé et denté sur les côtés postérieurs; élytres un peu moins larges que le prothorax, pas trés longs, subparalléles, finement et en partie ruguleusement ponctués; pattes robustes, foncées avec les cuisses en partie flaves ♂.

Long. 6 mill.

MINDANAO, Bukidnon Province, Tangkulan: Surigao, Nos. 17200, 17208.

Espèce très distincte par ses fortes antennes testacées; peut prendre place près de *D. rubrithorax* Pic.

Drilosilis suturalis sp. nov.

Parum elongatus, nitidus, niger, thorace rufo, abdomine pro parte et elytris ad suturam flavis.

Peu allongé, brillant, peu et finement pubescent, noir avec le prothorax roux, l'abdomen en partie flave, les élytres ornés

d'une macule suturale flave pouvant s'oblitére. Tête large; antennes robustes, en partie longuement pectinées; prothorax court et large, sinué sur les côtés, élargi en avant, angles postérieurs saillants derrière une petite échancrure; élytres à peu près de la largeur du prothorax, pas très longs, subparallèles, finement et en partie ruguleusement ponctués; pattes robustes, presque entièrement foncées ♀.

Long. 8 mill.

MINDANAO, Iligan, No. 17201.

Diffère, à première vue, du précédent, par la coloration foncée des antennes.

Les espèces qui suivent rentrent dans le groupe des Malthinini et sont nettement caracterisées par la brieveté des élytres, ces organes très courts étant longuement débordés par les ailes et l'abdomen, tandis que les espèces qui précédent, rentrant dans le groupe des Cantharini, ont les élytres normaux, non raccourcis.

L'étude des insectes de ce groupe est assez délicate parce que souvent on a affaire à des sujets plus ou moins déformés par la dessication, ou encore parce que l'on ne distingue pas assez bien certains de leurs organes importants.

Ayant l'intention d'étudier les Malthinini d'une façon complète dans un article, qui paraitra ultérieurement, et comprendra quelques espèces étrangéres aux Philippines, je me contenterai donc de donner ici l'énumération des espèces recueillies par Baker, avec les diagnoses préliminaires des formes jugées nouvelles et dont je donnerai plus tard une description complète.

Ichthyurus scripticollis Frm. et var.

MINDANAO, Iligan et Dapitan, Nos. 17163, 17164.

Ichthyurus bakeri sp. nov.

Elongatus, pro parte niger, pro parte flavus aut rufus; thorace flavo, ad medium transverse nigro fasciato; elytris flavis, lateraliter nigro lineatis et ad basin nigro fasciatis; pygidio rufo, in mare profonde inciso et longe bicaudato.

Long. 8–10 mill.

MINDANAO, Surigao. LUZON, Mount Banahao, Nos. 17166, 17167, 6674.

Très voisin de *I. scripticollis* Frm. distinct, à première vue, par le pygidium roux et de forme différente ♂, la bande transversale noire des élytres non prolongée jusqu'à la suture.

Ichthyurus bimaculatus sp. nov.

Elongatus, rufus, capite postice vage, antennis pro majore parte, 4 tibiis et tarsis anticis abdomineque pro parte nigris; thorace transverse nigro multimaculato; elytris rufis, lateraliter medio nigro lineatis et ad suturam antice nigro maculatis; pygidio late rufo, parum robusto, apice triangulariter inciso.

Long. 10 mill.

MINDANAO, Dapitan, No. 17165.

Espèce voisine de la précédente, très distincte par ses dessins noirs élytraux particuliers.

? **Ichthyurus pilicornis** sp. nov. ♀.

Satis, robustus, nitidus, luteo-testaceus, oculis antennisque, articulis primis exeptis, nigris, his pro parte opacis et dense pilosis, ad medium crassioribus; pygidio lato, apice mediocre et late, subarcuate inciso.

Long. 8 mill.

LUZON, Mount Limay, No. 8269.

Je range dubitativement cette espèce dans le genre *Ichthyurus* Westw., et près de *I. pallidus* Gestro, en attendant d'en connaitre le ♂. Très caractérisé par sa coloration générale claire jointe à sa structure antennaire.

Microichthyurus atripennis sp. nov. ♀.

Latis robustus, subnitidus, niger, capite, thorace et abdomine antice lateraliter flavo notatis; antennis pilosis, filiformibus, nigris, ad basin paulo rufescentibus; capite medio flavo bilineato; thorace breve et lato, in disco flavo lineato, antice ad medium flavo marginato, elytris brevibus, atris, pygidio satis valido, apice breve subtriangulariter inciso.

Long. 5 mill.

LUZON, Mount Maquiling, No. 6042.

Peut se placer près de *M. robustus* Pic, s'en distingue, à première vue, par les élytres concolores et l'avant-corps moins robuste.

Microichthyurus bicoloripennis sp. nov.

Parum elongatus, nitidus, testaceus, pro parte brunnescens, capite valido, thoraceque nigris, elytris brunnescentibus, apice testaceis; pedibus testaceis, pygidio brunnescente, lato, breve subtriangulariter inciso.

Microichthyurus bicoloripennis var. **baguionus** var. nov.

Capite et thorace brunnescentibus, elytris fere concoloribus.

Long. 4.5–5 mill.

LUZON, Benguet Subprovince, Baguio, Nos. 2398, 10181.

Diffère, à première vue, du précédent par les élytres non foncés, plus pâles à l'extrémité.

Tripherus bakeri sp. nov.

Elongatus et angustatus, nitidus, niger, antennis ad basin, thorace circa, pedibus pro parte et abdomine circa testaceis, elytris testaceis, concoloribus (forma typica), aut ad medium brunnescentibus et thorace nigro (var. *atrithorax*); pygidio angustato, apice minute inciso ♂, aut validiore et subtriangulariter inciso ♀.

Long. 10–12 mill.

MINDANAO, Zamboanga Province, Dapitan. BASILAN, Nos. 8278, 17161, 17162.

Espèce caractérisée par sa forme allongée, jointe à sa coloration.

Genus **FALSOMALTHINUS** novum

Capite validissime, thorace valde latiore, illo elongato, subparallelo; elytris thorace latioribus, brevibus, apice paulo dehiscentibus; abdomine apice simplice, non furcato.

Genre voisin de *Malthinus* Latr., dont il se distingue, à première vue, par la tête excessivement large et les élytres raccourcis.

Falsomalthinus pallidus sp. nov.

Elongatus, nitidus, pallidus, oculis nigris.

Long. 4–5 mill.

BASILAN, No. 7296. Aussi Borneo (coll. Baker et Pic).

HEIGHT, WEIGHT, AND CHEST MEASUREMENTS OF MONGOLIAN PEOPLES, WITH ESPECIAL REFERENCE TO SOUTHERN CHINESE

By WM. W. CADBURY

Of Canton Christian College, Canton, China

Comparatively little has been done in the anthropometry of the Mongolian peoples. During the past few years, in connection with several other investigators in China, I have been recording the height, weight, and chest measurements of normal Chinese men. In writing down these data, I have undertaken to gather together the available material bearing on this subject for the various divisions of the Mongolian stock.

According to Hrdlička (10) the Mongolians proper, though belonging to the great yellow-brown race, are a mixture of various local and even some western ethnic elements; while the Chinese "present in the main a people that has undergone to a very perceptible degree its own differentiation, so as to constitute a veritable great subtype of the yellow brown stem."

Deniker (3) declares that it is hard to say that there is only one race among the Mongols. There are two varieties: the Tungus, or northern Mongolians, with oval or round faces and prominent cheek bones, are spread over Manchuria, Korea, North China, and Mongolia; the southern Mongolians with lozenge-shaped or square faces and the cheek bones laterally enlarged, are found especially in South China and in Indo-China. The Yeniseians, called Tatars by the Russians, are not Mongolian. The Ainus are a group by themselves, different from all other peoples of Asia. They form a distinct factor in the Japanese race.

The Mongols proper are composed of three groups: the western Mongols, or Eleuts, or Kalmuks; the Torgoots in Zungaria; and the people of northwestern Mongolia (in this group are also included the Ala Shan and Kuku-nor tribes).

Eastern Mongols are found in Mongolia proper. In the south are the Tumets, Shaakars, and in the north, the Khalkas. The Buriats are sprung from the Khalkas.

The Thibetans are not all Mongolian. There is great variation in type. They include the Lolo and Miaotze people of China.

In eastern Asia Deniker(4) says there are three nations of mixed origin, namely:

1. The Chinese composed of five or six elements. Those of the south belong to the southern Mongolian race and are short. Those of the north are tall.
2. The Koreans are a mixture of Tungus, Indonesian, and Japanese. They are taller.
3. The Japanese are short. They are made up of crossings of the northern and southern Mongolian races with Indonesian or even Polynesian elements. The Ainu influence is seen in northern Japan.

Ivanovsky(15) speaks of the small amount of work that has been done on the anthropological study of the people of Asia. He concludes that there are eight anthropological groups in Asia, four of which are the South Chinese, Japanese, Ainus, and Mongols.

HEIGHT OF MONGOLIAN PEOPLES

Modern writers generally refer to the data given by Quetelet(26) as among the earliest that can be depended upon. Thus Topinard,(31) quoting that author, says that the height of man is about 1 meter at 5 years of age. At 15, it is 150 centimeters, and he grows 1.5 centimeters after he is 19 years old. The maximum height is reached at various ages, usually at 30 years. After 50 or 60 the height diminishes. By consulting tables of height according to age, however, it is noticeable that there is but little increase after the age of 18 years.

Gaup,(5) from a study of two hundred twenty Chinese children of both sexes in Peking, noted a marked cessation of growth in the fourteenth to the sixteenth year.

According to Hagen,(8) there was very slight growth in South Chinese after the twenty-fifth year.

In Mongols, according to Ivanovsky,(14) growth does not cease before the thirtieth year.

In Japanese soldiers, according to Koganei,(17) growth is not quite complete at the age of 24, but Miwa(25) says that the greatest height of Japanese occurs in the thirtieth year.

Misawa(24) makes the statement that most anthropologists claim that growth ceases at 17 years for all races except the white race. The mean average height of the entire population

of the globe is put by Topinard(31) at 165 centimeters and by Quetelet(26) for Europeans at 165 to 167.5 centimeters.

By far the most comprehensive study that I have seen of the height of the human species is presented by Martin;(21) he divides mankind into the small, the medium, and the large groups. In the first are individuals averaging 159.9 centimeters or less; in the second group are those of 160 and 169.9 centimeters; and the third includes all races in whom the male averages in height 170 centimeters or more. The tallest recorded people is the Sara tribe of Africa, averaging 181.7 centimeters, and the shortest people, the Pygmies of Mawambi in Africa, whose height averages only 140.8 centimeters.

Topinard(31) says of the stature of men in Asia that, in general, they are short and below the mean. Stature diminishes in the north in Siberia, and in the south approaching the Malay Peninsula; the height increases in the central portion of Asia, in the Japanese Islands, in China, and toward the Himalaya Mountains and Turkestan.

According to Ivanovsky,(15) it is generally believed that the main factors which influence height are race and heredity. However, there is no doubt that insufficient nourishment plays an important part in retarding growth. Social conditions, also, and hard muscular exertion have an important bearing on the question. He also states that the progeny of young mothers are shorter. Thus he cites the Japanese as being small because their women are married at the age of 11 or 12 years. Nevertheless, it remains true that stature is one of the most important of the data that go to make up the characteristics of race or tribe.

In considering the height of the Mongolian race, I shall take up the various divisions and compare the measurements of various investigators.

Beginning in the west, I shall consider the tribes of Chinese Turkestan, Thibet, Mongolia, and Manchuria and the aborigines of China; then the Ainus, Japanese, and Koreans. Next in order I shall consider the inhabitants of Indo-China and, finally, shall study the Chinese themselves, first the northern and southern divisions and, lastly, the classification according to provinces.

Sir Aurel Stein(29) determined the heights of more than six hundred individuals representing twenty-four tribes in eastern Turkestan and the Pamirs, besides twenty Chinese tribes who had emigrated from China. The westernmost tribe was

TABLE 1.—*Heights and weights of the different divisions of the Mongolian race.*

Region, tribe, or province.	Reference.	Class or occupation.	Age.	Average height.	Number in height series.	Average weight.	Number in weight series.	Weight-for-height index.
			yrs.	*cm.*		*kg.*		
Various tribes in eastern Turkestan	Stein (29)		(a)	164.9	600			
Chinese emigrants to eastern Turkestan.	do		(a)	166.7	20			
Kirghizens	Ivanovsky, quoted by Martin (21)			165.1				
Thibetans	Troll		(a)	165	37			
Do	Risley		(a)	163.3	105			
Do	Delisle		(a)	167.3	11			
Do	Montegazza		(a)	157.7	2			
	All quoted by Ivanovsky (15).							
Average (Thibetans)			(a)	164	155			
Aborigines:								
Formosans	Torii, quoted by Martin (21)			160.5	1			
Lolos	Legendre (19)		(a)	167.5	29			
Miaotze	Ryuzo-Torii, quoted by Martin (21)			155				
Mongols:								
North Chinese	Talko-Hryncewicz (30)	Merchants in northern Mongolia.	21–55	164.24	54			
Buriats (Trans-Baikal)	do			163.12	544			
Mongol Khalkas	do			161.08	36			
Kalmuks	Ivanovsky (14)			162.9	296			
Do	Deniker, quoted by Martin (21)			163.4				
Average (Kalmuks)				163.1				
Mongols, general	Ivanovsky (14)					64.29		
Tungus	Mainoff, quoted by Martin (21)			162.7				
Do	Talko-Hryncewicz (30)			163.8	45			
Do	Jochelson, quoted by Ivanovsky (15)			157.4	22			
Do	do			156.5	52			

Do	do			158.8	9			
Average (Tungus)				159.8				
Manchus	Gaup (5)			171	5			
Do	Ujfalvy, quoted by Ivanovsky (15)			169	8			
Average (Manchus)				170	13			
Ainus	Koganei (16)		20-68	156.7	95	64	3	
Do	Sakaki, quoted by Ivanovsky (15)			158.1	70			
Average (Ainus)				157.4	165			
Japanese	Koganei (17)	Soldiers 1900		162.1	6,279	57.7	6,279	355
Do	do	Soldiers 1901		164.2	7,580	59	7,580	
Do	Koganei, quoted by Ivanovsky (15)			157.7	50			
Do	Deniker (3)			159				
Do	do	Coolies		157				
Do	Indo (13)		29	160.9	774	52.99	3,772	329
Do	Miwa (25)		29	159.6		53.7	37	336
Do	Rozgdestvensky, quoted by Ivanovsky (15)			157.3	19			
Do	Soller, quoted by Ivanovsky (15)			157.8	15			
Do	Weisbach, quoted by Ivanovsky (15)			156.9	12			
Do	Baelz, quoted by Ivanovsky (15)			159	1,727			
Do	do	Students		161.5	53			
Do	do	Laborers		161.9	13			
Do	do			162	4			
Do	Ijima, quoted by Martin (21)					52-56		
Average (Japanese)				159.7		55.5		
Koreans	Koike (18)		20-50	179.9	75	60.73	75	
Do	Migita and Otsuka, quoted by Koganei (17).		20-55	162.5	128	58.1	128	357
Do	Ijima, quoted by Koganei (17)	Soldiers	21-50	163.1	2.518	59.2	594	
Do	Elisseieff, quoted by Koganei (17)			162	10			
Do	Chantre and Bourdaret, quoted by Ivanovsky (15).			161.5	113			
Average (Koreans) [b]				162.2		58.6		

[a] Adults.

[b] Koike's figures not included.

TABLE 1.—*Heights and weights of the different divisions of the Mongolian race*—Continued.

Region, tribe, or province.	Reference.	Class or occupation.	Age.	Average height.	Number in height series.	Average weight.	Number in weight series.	Weight-for-height index.
			yrs.	*cm.*		*kg.*		
Annamites	Breton (1)	From Saigon		157.7				
Do	Girard (6)	do		158.9				
Do	Deniker (3)	In general		158.3				
Do	Paris			156.6	10			
Do	Roux			162	69			
Do	Deniker and Bonifacy	Cochin-China		158.3	21			
Do	Deniker and Laloy	do		156.5	30			
Do	Deniker and Bonifacy	Tongking		158.4	21			
Do	Deniker and Laloy	do		162.7	23			
	All quoted by Ivanovsky (15).							
Do	Mondiére and Bonifacy, quoted by Martin (21).			158.7		51.3		323
Average (Annamites)				158.8				
Cochin-Chinese	Deniker and others, quoted by Martin (21).			157.8				
Do	Girard (6)			157.3	132			
Formosan Chinese	Taniguchi, Sakamoto, and Yamato, quoted by Koganei (17).	Mostly coolies	21–40	161.7	544	50		
Siamese	Weisbach, quoted by Ivanovsky (15)			162.2	8			
Do	Annandale, quoted by Martin (21)			159.9				
Do	Hagen (8)			160.5	2			
Do	Deniker (3)			160.7				
Average (Siamese)				160.8				
Tongkingese	Breton (1)	Hanoi and Haiphong		157.39				
Do	Deniker and Bonifacy, quoted by Martin (21).			158.4				

Do	Girard (6)			159	76			
Average (Tongkingese)				158.3				
Chinese:								
All China	Shoemaker (27)	Students	20	166.5		52.2		
North China	Hagen (7)			167.6				
Do	Koganei (17)	Soldiers	25–66	167.6	942	64.4	942	384
Do	Deniker (3)	Chefu and Kuldja		167.4				
Do	Shoemaker (28)	Peking students		165.3	380	54.3	380	328
South China	Weisbach (32)	Prisoners, etc	20–49	163	26			
Do	Crook (2)	Students	20	166.6	34	51	34	
Do	Girard (6)	Collected data		161.6	1,047			
Do	Deniker (3)	In Longchow		161.5				
Do	Whyte (35)		(a)	163	1,741	50.2		295–335
Anhwei	Hutcheson (12)		(a)	164.6	29	50.8	27	
Chekiang	do		(a)	162.8	258	52.8	259	324
Chihli	Gaup (5)			167				
Do	Hutcheson (12)		(a)	168.9	261	57.3	259	339
Fukien	do		(a)	166.3	5	50.8	5	
Hoklos	Whyte (34)	Convalescent patients	(a)	162.7	1,021	[c] 54.4		
Honan	Gaup (5)			174				
Hunan	Hutcheson (12)		(a)	161.5	267	50.1	354	310
Hupeh	do		(a)	163.5	9	50.8	8	
Hupeh (Wuchang)	Merrins (23)	Students	(a)	168.9		54.2		
Kiangsi	Hutcheson (12)		(a)			51.5	14	
Kiangsu	do		(a)	166.1	709	55.4	696	333
Kwangsi	Girard (6)			161.5	25			
Kwangtung	Breton (1)	Cantonese	22–37	165.8	15			
Do	Hagen (8)	Sumatra coolies	25–60	162.2	15,582			
Do	Cadbury	Students	20–36	163.6	110	51.9	110	317
Do	Hutcheson (12)		(a)	160.7	232	55	203	342
Kweichow	do		(a)	166.6	8	58.9	8	

[a] Adults.

[c] Estimated from the height.

TABLE 1.—*Heights and weights of the different divisions of the Mongolian race*—Continued.

Region, tribe, or province.	Reference.	Class or occupation.	Age.	Average height.	Number in height series.	Average weight.	Number in weight series.	Weight-for-height index.
			yrs.	*cm.*		*kg.*		
Shantung	Koganei (17) quoting Janka	Chefu laborers	17-35	167.5	20			
Do	Gaup (5)			173				
Do	Hutcheson (12)		([a])	167.6	5	54.8	5	
Do	Merrins (23)	Students	([a])	170.2		63.96		
Szechuan	Hutcheson (12)		([a])			49.6	4	
Do	Legendre (20)			161.1	100			
Do	Wilford (33)	Students	[d] 18	166.1	70	45.8	70	

[a] Adults.

[d] Average.

that of the Kafirs of Kafiristan and, farther east, the tribes of the Taklamakan Desert and of Khotan, and other tribes to the north and east. The extremes of height were 160 and 170 centimeters. The average for all the tribes was 164.9 centimeters, while the Chinese emigrants to this region averaged 166.7 centimeters.

Coming now to the Thibetans, I find a classification made by Ivanovsky,(15) who gives the average height as 164 centimeters.

The aborigines of China are closely allied to the Thibetan tribes. I have obtained data for the Formosans and Miaotze (see Table 1). These peoples are confined to the mountains and are of short stature.

Legendre(19) reports on twenty-nine males of the Lolos tribe. These aborigines live in the mountains of southern Szechuan. Their height varied from 156 to 178 centimeters, and the average height was 167.5 centimeters.

Reference has already been made to the distribution of the Mongols in the Chinese Empire. They are also found in the Russian Empire, according to Hrdlička,(11) distributed as follows: European Russia, 0.2 per cent of population; Caucasus, 0.2 per cent of population; Siberia, 6.2 per cent of population; central Asia, 0.2 per cent of population.

Deniker(3) says that the type of the Mongolian race has a stature of 163 to 164 centimeters, with a subbrachycephalic head.

Ivanovsky(14) examined especially members of the Torgout tribe, generally called Kalmuks, in the valley of Kobok Zari, south of Tarbagatai. He concludes that Mongols are of medium size. Of two hundred ninety-six measurements, 34.48 per cent were below 165 centimeters and 64.52 per cent above.

Gaup(5) found the Mongols in Peking to be short. In three cases examined the mean height was 165 centimeters. He did find some, however, who measured as much as 196 centimeters.

Talko-Hryncewicz(30) studied the heights of fifty-four males between the ages of 17 and 55 years. They were North Chinese merchants who had migrated from Siberia to northern Mongolia to the towns of Maimachin and Kyakhta in Urga. Excluding five who were between 17 and 20 years of age, there remained forty-nine adults. The average height of these was 164.24 centimeters. He goes on to show the differences between the maximum and minimum heights of different races as follows:

In these 49 North Chinese, the heights varied from 153 to 172 centimeters; in 25 South Chinese, from 152.8 to 174.8 cen-

timeters; in 544 Buriats, from 135 to 185 centimeters; in 36 Khalkas, from 146 to 175 centimeters; in 45 Tungus, from 146 to 186 centimeters; and in 296 Kalmuks it varied from 151.1 to 175 centimeters.

The differences between maximum and minimum heights were as follows: North Chinese, 19 centimeters; South Chinese, 22; Kalmuks, 23.9; Khalkas, 29; Buriats, 50; Tungus, 40.

In Table 2 is seen the relative proportion of six groups of Mongols found in the different height categories. The greatest proportion of North Chinese belong to the medium-height group, while the South Chinese have the smallest percentage in this group and the largest percentage in the short group. The other Mongol tribes lie between these extremes.

TABLE 2.—*Relative height proportions of six groups of Mongols.*

Height.	49 North Chinese.	25 South Chinese.	296 Kalmuks.	544 Buriats.	36 Mongol Khalkas.	45 Tungus.
cm.						
159 or under	14.2	40	31.75	25.34	33.34	28.89
160 to 169	75.5	51.9	57.10	61.58	58.33	66.67
170 and over	10.2	8	11.15	13.05	8.33	4.44

Several studies of the height of Tungus are recorded in Table 1; they average only 159.8 centimeters. The Manchus are reported by Gaup(5) as averaging 175 to 176 centimeters; he examined five cases which averaged 171 centimeters. The Ainus are different in many respects from the other branches of the yellow-brown races, but must be included here because of their influence upon the Japanese and Koreans.

Koganei(16) has made a study of these people. He measured the heights of 166 persons, 95 men and 71 women. The ages of the men varied from 20 to 68 years, and their average height was 156.7 centimeters. The minimum was 141 centimeters and the maximum 173 centimeters. The majority of the men ranged from 154.5 to 160 centimeters. He quotes Scheube, who measured 6 males with a similar average.

According to Ivanovsky,(15) the Japanese type is a fairly distinct one. The Japanese are characterized by short stature. and do not show close resemblance to any other race. They constitute an independent anthropological group. According to Deniker,(3) they originate from crossings of northern and southern Mongol races, with Indonesian or even Polynesian elements.

Indo,(13) quoted by Koganei,(16) gives the heights of 20,000 males, aged 15 to 60 years. The maximum height reached by

these men occurred at the age of 30. The average at this age is 160.9 centimeters.

Miwa(25) measured 10,490 Japanese of both sexes from birth to 80 years of age. The average height of those of 30 years of age was 159.6 centimeters.

The Koreans, according to Deniker,(3) are a mixture of Tungus, Indonesians, and Japanese. Koike(18) gives the average height as 179.9 centimeters for 75 men measured, and Migita and Otsuka, as 162.5 centimeters. There seems no doubt that Koike's figure is too high, and 162.2 centimeters may be considered a fair average height.

The peoples of Indo-China, while forming a rather distinct type, are nevertheless closely allied to the Mongolian race. In this group there are the Annamites, averaging 158.8 centimeters in height; men from Cochin-China, averaging 157.5; from Siam, averaging 160.8; and from Tongking, averaging 158.3. The averages for all these peoples of Indo-China and Siam puts them in the class of short men.

TABLE 3.—*Average or mean heights of different members of Mongolian race.*

Race or tribe.	Height in centimeters.
Manchus	170
Lolos	167.5
North Chinese	166.97
Chinese in eastern Turkestan	166.7
Kirghizens	165.1
All Chinese	165
Tribes of eastern Turkestan	164.9
Chinese of northern Mongolia	164.24
Thibetans	164
Buriats	163.12
Kalmuks	163.1
South Chinese	163.1
Koreans	162.2
Khalkas	161.08
Siamese	160.8
Formosans	160.5
Tungus	159.8
Japanese	159.7
Annamites	158.8
Tongkingese	158.3
Cochin-Chinese	157.5
Ainus	157.4
Miaotze	155

Having considered the various other branches of the Mongolian race, I come now to a consideration of the Chinese people.

The earliest study that I have been able to find is that of Weisbach,(32) who reports measurements taken of various tribes during the voyage of the frigate *Novara*. The heights were taken by Scherzer and Schwarz, during the ship's stay at Hongkong, of 26 males, 21 of them Puntis and 5 Hakkas. The subjects were found in the prison and hospitals of the city. They were all born in South China. The heights varied from 152 to 174.4 centimeters. Thus, the mean was 163 centimeters, and 30.7 per cent measured from 160 to 164.9 centimeters.

Breton(1) reports on 15 Cantonese, 22 to 37 years of age, who averaged 165.8 centimeters.

Hagen's(7) first report includes the measurements of 1,007 coolies from South China. There was one, a dwarf, measuring only 122 centimeters. The average height was 162.2 centimeters. These data are included in his more comprehensive study(8) of the Chinese people of Deli, in Sumatra. The South Chinese are very numerous there, where they serve as coolies on the great tobacco plantations. They come from Kwangtung Province and are chiefly Hakkas, with a few Hoklos. Hagen has gathered data for 15,582 of these South Chinese. The heights for different age groups are shown in Table 4.

TABLE 4.—*Heights of various age groups of South Chinese.*

Age.	Number examined.	Average height.
Years.		*cm.*
15 to 19	400	158.4
20 to 24	4,375	160.8
25 to 29	4,354	162.1
30 to 34	3,337	162.2
35 to 39	2,046	162.2
40 to 49	1,013	162.3
50 to 60	60	161.5

For those aged 25 to 60 years, the mean height was 162.2 centimeters.

Hagen concludes that the South Chinese demonstrate in their bodily structure that they have a mixture of the Malay race. The North Chinese, on the other hand, who have no Malay characteristics, have almost never traveled in the Malay countries. In a later communication Hagen(9) states that the average height of the North Chinese is 167.6 centimeters. A pure-blooded Chinese from Hainan measured 159 centimeters, and a Fukien Chinese 179 centimeters.

Crook(2) records the measurements of Chinese students at Queen's College in Hongkong. They are presumably all from the south of China. Those aged 20 averaged 166.6 centimeters.

Koganei(17) has contributed a most extensive study on the measurements of Chinese in the north. He measured the heights of 942 Chinese soldiers who were captured during the Chino-Japanese war. These men varied in age from 20 to 66 years (25 who were under 20 years are not included). The majority came from the Provinces of Shantung, Chihli, Honan, Chekiang, Anhwei, and Kiangsu, and from Manchuria. Very few were natives of the other provinces. Thus, practically all may be classed as North Chinese. The average height was 167.6 centimeters, with extreme variations from 148 to 186 centimeters. Among 942 men the percentages of different heights were as follows:

Per cent.	Height in centimeters.
7.3	Under 160
22.1	160 to 165
38.4	165 to 170
32.2	170 and over

Koganei quotes Janka's figures for 20 Chinese laborers in Chefu. These were aged 17 to 35 years, but only 5 of them were under 20. The average height of these was 167.5 centimeters. Koganei also refers to the measurements of 544 Formosan Chinese, mostly coolies, in Tainan. The heights of these averaged 161.7 centimeters.

Girard(6) obtained the heights of 25 Chinese from Kwangsi Province, on the borders of Tongking. Their mean height was 161.5 centimeters, while the maximum was 174.8, and the minimum 152.8. Girard refers to a collection made by Deniker and Laloy of the heights of 1,047 South Chinese. The average for these was 161.6 centimeters.

Deniker(3) gives the measurements of South Chinese of Longchow as 161.5 centimeters, and of North Chinese from Chefu and Kuldja as 167.4 centimeters.

Gaup(5) examined 38 Chinese in Peking, from different provinces; the average height was 167.4 centimeters. Those from Shantung measured 173 centimeters, from Honan 174, from Chihli 167, while those from Shanghai and Ningpo were 163 and 157 centimeters in height. He states that it is generally conceded that the largest Chinese are those from Honan Province, where the first immigration of Chinese took place.

Merrins(23) records the measurements of 219 schoolboys at Wuchang in Hupeh Province. The height of those who had "practically finished growing" was 168.9 centimeters. He also quotes the figures on grown boys at the Shantung Union College, collected by Doctor Roys. These Shantung students averaged 170.2 centimeters in height.

The height of the Hoklo people, inhabiting the southeastern coast of China, has been studied by Whyte.(34) These people are better known as the Swatow men, from the name of the port in Kwangtung Province from which many of them emigrate to other countries. All subjects were males and hospital patients over 17 years of age. There were 1,047 examined. Three-fourths of the cases measured between 157.5 and 167.6 centimeters, the average for all being 162.7 centimeters.

Legendre(20) examined 100 male Chinese from Chengtu, the capital of Szechuan Province. Of these the tallest 30 averaged 168.1 centimeters, the shortest 30, 153.7, while the 40 of medium height averaged 161.4 centimeters.

Shoemaker has taken the heights of students in Tsinghua College in Peking. In his first report,(27) students from all sections of China are grouped together. Those aged 20 years averaged 166.5 centimeters in height. Shoemaker is quoted by Whyte(28) as to the data secured from Peking or North China boys. Of these, 380, who were full grown, averaged 165.3 centimeters in height.

A careful study on behalf of the research committee of the China Medical Missionary Association is contributed by Whyte.(35) In this is included the study of Hoklos mentioned above, making altogether 1,741 adult males. All but 16 of these were from the provinces of Fukien and Kwangtung. For all of these adult males, the average height is 163 centimeters. The greatest number of these South Chinese are found at the point, 162.56 centimeters, in a curve showing number of individuals of a given height.

A second and more comprehensive report of the research committee of the China Medical Missionary Association is edited by Hutcheson.(12) The data for this report were collected by fourteen physicians, most of whom lived in China. Altogether, measurements of 3,143 males and 215 females were collected. Hutcheson finds that heights of Chinese "beginning at Canton increase steadily up to Peking." The measurements of adult coolies are much higher than measurements of students of the same province.

The heights of Chinese from ten provinces are recorded (see Tables 1 and 5).

Wilford (33) has added a few data for students in Chengtu, Szechuan, whose average height was 166.1 centimeters.

TABLE 5.—*Average of mean heights of Chinese males in the different regions of China.*

Region or province.	Height in centimeters.
Honan	174
Shantung	169.6
Chihli	167.9
North China	166.97
Kweichow	166.6
All China (students)	166.5
Fukien	166.3
Hupeh	166.2
Kiangsu	166.1
Anhwei	164.6
Kwangtung	163.78
Szechuan	163.6
South China	163.1
Chekiang	162.8
Hoklos	162.7
Formosa	161.7
Hunan	161.5
Kwangsi	161.5

In addition to the above, I add the measurements of 110 male students of the Canton Christian College, 20 to 36 years of age (see Table 6). The maximum height was 177.2 centimeters; the minimum was 148.6 centimeters, in the one student who was 36 years old. The average height for all the students was 163.6 centimeters.

For age 20 there were 54 recorded. Of these 16.4 per cent were of a height between 152.4 and 160 centimeters; 63.6 per cent were between 160 and 167.6 centimeters; while 20 per cent were from 167.6 to 174 centimeters in height. It will be noted that the average of adult Cantonese men as given by Hutcheson is 2.9 centimeters less than my figures. This is doubtless because students at the Canton Christian College come largely from well-to-do families and have better opportunity for physical development than the average schoolboy of the province. The Cantonese coolies reported by Hagen are also shorter, for the reason that they are not so well nourished.

Comparing now the figures in Table 5, I find that the Chinese vary in height from 174 centimeters in Honan Province to 161.5

TABLE 6.—*Heights, weights, and chest measurements of male Chinese students of the Canton Christian College.*

Age.	Cases.	Height.			Weight.		
		Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.
Years.		*cm.*	*cm.*	*cm.*	*kg.*	*kg.*	*kg.*
20	54	165.1	174	153	50.3	64.7	42.5
21	26	165.1	177.2	153.6	49.4	57.1	43.1
22	15	167	172.7	159.4	52.6	62.6	44.9
23	5	167	169.5	162.5	50.6	55.2	45.8
24	2	170.8	173.3	169.5	54.8	58.5	51.1
25	1	169.5			62.3		
26	1	168.9			61.3		
27	1	162.5			51.2		
28	0						
29	1	160.6			48.3		
30	1	162.5			46.5		
31	2	156.2	158.1	154.9	52.5	55.9	49
36	1	148.6			43.2		

Age.	Circumference of chest.									Play of chest.
	At full inspiration.			At full expiration.			At rest or mean.			
	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	
Years.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
20	83	93	75	77	83	69	79	85	70	6
21	80	86	67	74	81	64	75	82	65	6
22	83	89	77	75	82	68	78	85	70	8
23	83	90	79	74	81	74	77	85	76	9
24	83	90	77	78	85	71	81	87	75	5
25	87.5			83			85			4.5
26	87			81			83			6
27	82.5			78			80			4.5
28										
29	83.5			79			80.5			4.5
30	80			71			73			9
31	84.5	89	80	79	85	74	81	87	76	5
36	77			70			75			7

centimeters in Hunan and Kwangsi, the latter on the borders of Indo-China. The average for all Chinese is 165 centimeters, or the average for all mankind as given by Topinard. There is a marked difference, however, between the peoples north and those south of the Yangtze River. Taking all the groups of Chinese given in Table 1, we may divide them into North and

South Chinese. Since the Yangtze River flows right through the Provinces of Szechuan and Anhwei, we shall omit those provinces from the list (see Table 1). The heights, in centimeters, average as follows for the respective groups:

North Chinese:	South Chinese:
167.6	163
167.6	166.6
167.4	161.6
165.3	161.5
167	163
168.9	162.8
174	166.3
163.5	162.7
168.9	161.5
166.1	161.5
	165.8
	162.2
	163.6
	160.7
	166.6

Thus, the general average for the peoples north of the river is 167.6 centimeters, while for the peoples south of the river the height averages 163.2 centimeters.

I may say that in a general way the Mongolian people can be divided into tall (over 165 centimeters), medium (160 to 165 centimeters), and short (under 160 centimeters). In the first group belong the Manchus, the Lolos, and the Chinese of Honan, Shantung, Chihli, Kweichow, Fukien, Hupeh, and Kiangsu, and North Chinese in general. In the medium group are the people of eastern Turkestan, Mongolia, and Thibet, the Buriats, Kalmuks, Koreans, Khalkas, Siamese, and the Chinese of Anhwei, Kwangtung, Szechuan, Chekiang, Hunan, Kwangsi, and Formosa, the Hoklo people, and the South Chinese in general. In the short group are to be classed the Tungus, Japanese, Annamites, Tongkingese, Cochin-Chinese, Ainus, and Miaotze.

WEIGHT OF MONGOLIAN PEOPLES

Weight, as Topinard(31) states, does not have the importance from the anthropological point of view that height does. It depends on too many factors; namely, the state of nutrition, the health and occupation of the individual, etc.

According to Martin,(21) the average weight of Europeans, stripped, is 65 kilograms. Races that are of lower average weight are often found to be poorly nourished. Quetelet(26)

gives 66 kilograms, and McCay(22) considers 70 kilograms as the average for European adult males.

TABLE 7.—*The weights of males of the various groups of the Mongolian race.*

Race, region, or province.	Weight in kilograms.
Mongols	64.29
Ainus	64
Shantung	59.38
North China	59.3
Kweichow	58.9
Koreans	58.6
Chihli	57.3
Japanese	55.5
Kiangsu	55.4
Hoklos	54.4
Kwangtung	53.4
Chekiang	52.8
Hupeh	52.5
Kiangsi	51.5
Annamites	51.3
Anhwei	50.8
Fukien	50.8
South China	50.6
Hunan	50.1
Szechuan	47.7

Ivanovsky(14) gives 64.29 kilograms (157 Russian pounds) as the average weight of Mongols. They vary from 49 to 83 kilograms.

Koganei(16) determined the weight of only 3 Ainu males, who weighed 63, 65.2, and 64 kilograms, giving an average of 64 kilograms.

For the Japanese soldiers Koganei(17) finds an average of 56 to 59 kilograms. For ordinary Japanese, he gives Indo's average for 3,772 persons of 26 to 30 years, as 52.99 kilograms. The greatest body weight occurred in men between 46 and 50 years of age, who averaged 55.57 kilograms. According to Miwa,(25) the greatest weight occurs at 39 and the average of 37 men at this age was 53.71 kilograms. Martin(21) quotes Ijima as giving 52.7 to 56.2 kilograms as the average weight of Japanese.

Coming now to consider the Koreans, I find data again supplied by Koganei.(17) Koike(18) gives the figures for 75 Koreans in Fusan, aged 20 to 50 years. Their weight averaged 60.73 kilograms, but this, as well as Koike's figure for height, seems too high. Migita and Otsuka(17) measured 128, between 20 and 55 years of age, with an average weight of 58.1 kilo-

grams. The average weight of 594 of Ijima's cases, aged 21 to 50 years, was 59.2 kilograms.

The weight of Annamites is given by Martin (21) as 51.3 kilograms, quoting Bonifacy.

Coming now to the Chinese, Koganei (17) found the weight in 942 North Chinese soldiers to average 64.38 kilograms, with extreme variations of 37.5 and 91.5 kilograms. He quotes Taniguchi, Sakamoto, and Yamato as giving the weight of Formosan Chinese as follows:

Age in years.	Weight in kilograms.
21 to 25	49.74
26 to 30	49.87
31 to 35	49.57
36 to 40	50.93

The average for all amounts to 50 kilograms.

Crook's (2) weight for boys in Hongkong, aged 20 years, was 51 kilograms. Merrins's (23) records are for schoolboys who had finished growth, at a school in Wuchang, Hupeh, and also grown students at Shantung.

Whyte, (34) in his study of the Hoklos, emphasizes the influence of height on the weight of these people and, since some of these subjects were suffering from disease, I have estimated the weight from the average height according to Whyte's rule (see page 752).

My own study of weights of Chinese students is shown in Table 6. I have assumed that increase of growth in height has practically ceased at 20 years of age. The average weight of those of 20 years or over is 51 kilograms. In order to determine the frequency of occurrence of different weights, I may select the subjects of 20 and 21 years of age, of whom 80 were recorded. The weights of these were distributed as follows:

Kilograms.	Per cent.
42 to 46	22.2
47 to 50	24.7
51 to 54	29.6
55 to 59	18.5
60 to 65	5.0

More than half weighed between 47 and 54 kilograms. These figures correspond closely with Crook's average for students and with Whyte's figures.

Hutcheson's figures for Kwangtung are higher, and he doubtless included more mature men.

Now, grouping the Chinese north and south of the Yangtze River, excluding Anhwei and Szechuan, as in the study of height, we find the following weights in kilograms:

North of Yangtze:	South of Yangtze:
64.4	58.9
63.9	55
57.3	54.4
55.4	52.8
54.8	51.9
54.3	51.5
54.2	51
50.8	50.8
	50.2
	50.1

North of the Yangtze, then, the average weight is 56.9 kilograms, while south of the river it is 52.6 kilograms.

The Chinese are considerably inferior in weight to all European and American peoples.

The Mongols, Ainus, and Koreans are heavier than the average Chinese.

The Japanese stand between the Chinese of the north and south, while the Annamites, and doubtless the other peoples of Indo-China, weigh considerably less than even the South Chinese.

HEIGHT-TO-WEIGHT RATIO

Martin(21) emphasizes the value of this factor for grown as well as for growing individuals.

Whyte(35) refers to the value of the weight-for-height index, obtained by dividing the weight in grams by the height in centimeters. In England he says that this varies from 402 to 447 or even 536 grams for every centimeter of stature.

From his study of the people of Swatow, Whyte gives the following rule for determining the standard weight for the height:

Deduct 24 from the number of inches representing height and multiply the result by 3, which gives the number of pounds that the individual should weigh.

Broca's rule is to deduct 100 from the height in centimeters and call the remainder kilograms. If this is diminished by 20 per cent, it may be found of value for people in South China.

The weight-for-height index of Chinese in North China is 329 grams, and for South China 313 grams, for each centimeter.

Reference can be made to Table 1, where the weight-for-height index is given in a few instances. For the Chinese soldiers, it

amounted to 384, but for Chinese in civil walks of life it averaged only from 310 to 342.

For Japanese soldiers we get an index of 355 and for ordinary persons, according to Indo's figures, 329 and, according to Miwa, 336. For Koreans, 357 is the index, and for Annamites 323. Thus, for all these Mongolian peoples, the weight-for-height index is below the European standard due, doubtless, to the undernourished condition of the people.

CHEST CIRCUMFERENCE IN MONGOLIAN PEOPLES

Topinard(31) has noted the fact that European races have not only a greater circumference of the chest, but a greater play of the chest between inspiration and expiration.

Ivanovsky's(14) average for chest circumference of Mongols is 86 centimeters, with a minimum of 80 and a maximum of 99.

Talko-Hryncewicz(30) measured the chests of 43 North Chinese merchants from northern Mongolia. For these the average was 81.4 centimeters with a minimum of 70 and a maximum of 98. In 69.7 per cent the chest measured from 75 to 85 centimeters. He gives also the data for other Mongolian tribes (see Table 8). Thus, the chest measurements of the North Chinese are 5 to 6 centimeters smaller than those of the Khalkas, Buriats, and Tungus.

The relative percentage of chest circumference to height of these North Chinese is 49.6, varying from 42.77 in one case to about 55 in the largest case. In Table 8 is given the relative percentage for the other Mongolian tribes, showing that these have chests with a circumference more than half the height. He finds that the chest circumference is relatively greater, as compared with height, in the years between 26 and 30, but is relatively smaller from 31 to 35 years, and also at other ages.

Comparing his figures with those obtainable for other tribes in the Orient, he finds that the latter peoples have a chest circumference greater than one-half the height. Hence, he concludes that in shorter people there is apt to be a relatively greater chest circumference.

Koganei(16) in his study of the Ainus found the average circumference of the chest in males to be 90.4 centimeters, with extremes of 81 and 105.5 centimeters. For Japanese, Koganei(16) quotes Baelz (see Table 8). Koganei(17) also gives the circumference of the chest in Japanese soldiers. These are divided into four groups for the years 1900 and 1901. For the former the average of 6,279 was 85.5 centimeters, and the excur-

TABLE 8.—*Chest measurements of the different divisions of the Mongolian race.*

Region, tribe, or province.	Reference.	Class or occupation.	Age.	Circumference of chest.			Play of chest.	Chest circumference to height.
				At rest.	Inspiration.	Expiration.		
			Years.	*cm.*	*cm.*	*cm.*	*cm.*	*Per cent.*
Mongols:								
North Chinese	Talko-Hryncewitz (30)	Merchants	21–55	81.4				49.6
Buriats	do			88				53.84
Mongol Khalkas	do			87.2				54.01
Tungus	do			86.4				53
In general	Ivanovsky (14)			86				
Ainus	Koganei (16)		20–68	90.4				57.7
Japanese	Koganei (17)	Soldiers 1900		85.5			7	
Do	do	Soldiers 1901		85.7			7.2	52
Do	Baelz, quoted by Koganei (16)	Gentlemen		76.8				47.4
Do	do	Students		77.6				48
Do	do	Laborers		85.2				52.6
Koreans	Koike (18)			83.1			5.7	
Do	Migita and Otsuka, quoted by Koganei (17).		20–55	85			6.3	50.3–53.5
Do	Ijima, quoted by Koganei (17)	Soldiers	21–50	80.8			5.6	49.5
Siamese	Hagen (8)			84.5				
Tongkingese	Breton (1)			79.46				50.4
North Chinese	Koganei (17)	Soldiers		86.9			6.3	51.8
Do	Shoemaker	Students		79.9				
South Chinese	Weisbach (32)	Prisoners	20–49	85.7				52.6
Do	Crook (2)	Students	20	77.4	81.7			
Do	Whyte (35)					77.1		
Anhwei	Hutcheson (12)					77.7		
Chekiang	do					75.1		
Chihli	do					77.2		

Fukien	do					82.3		
Hunan	do					84		
Hupeh	do					79.5		
Hupeh (Wuchang)	Merrins(23)	Students		83.8				
Kiangsi	Hutcheson(12)					76.2		
Kiangsu	do					76.7		
Kwangtung	Hagen(8)	Sumatra coolies	25–60	83.2			5.2	51.2
Do	Cadbury	Students	20–36	78.9	83	76.5		48
Do	Hutcheson(12)					77		
Kweichow	do					83.3		
Shantung	Janka, quoted by Koganei(17)	Chefu coolies	17–35	84.9				50.6
Do	Hutcheson(12)					80.6		
Szechuan	Wilford(33)	Students	[a] 18		79.4	72.9	6.5	

[a] Average.

sion of the thorax averaged 7. In the 1901 group, 7,580 soldiers gave an average of 85.7 centimeters with an excursion average of 7.2. The Koreans' breast measurements are also given by Koganei (see Table 8).

Breton(1) gives the circumference of the chest in 53 men from Hanoi and Haiphong in Tongking as 79.46 centimeters.

Coming now to the Chinese, I have the important studies of Hagen on Chinese coolies in Sumatra, emigrants from Kwangtung Province. He measured the circumference of the chest just above the nipples, halfway between inspiration and expiration, with the arms hanging down. The average circumference was 83.2 centimeters.

Koganei(17) found an average of 86.9 centimeters for North Chinese soldiers, with an average chest excursion of 6.3 centimeters; and, using Hagen's figures for deep expiration and inspiration, he finds an excursion of 5.17 for South Chinese.

Martin(21) gives 49.9 as the percentage of chest circumference to height in Annamites and 52 in the Lolos.

The character of labor counts for much in collecting data of the chest. Students in China are proverbially flat-chested. The largest series of facts is contributed by Hutcheson, but he records only "expiration," a rather less dependable measurement than the circumference while at rest. It is evident, however, that the chest of the Chinese is considerably smaller than that of European peoples.

Measurements taken by me are to be found in Table 6. Since these were taken from students, many of them athletic, it can be concluded that they are better than would be found in the average South Chinese, excluding boatmen and other laborers who constantly use their arms and their chest muscles. More important than the circumference is the excursion, or play, of the chest or the difference in the girth of the thorax, across the nipples, at full inspiration and at full expiration.

Our Cantonese college students of 20 to 23 years of age (see Table 9) have an expansion of 6 centimeters in the majority of cases, and more than half of them average from 6 to 8 centimeters.

By reference to Table 8 it will be noted that the people with the largest chests are the Ainus, in whom the chest is also proportionately greater with reference to height. After these come the Mongolian tribes and the North Chinese. The people of South China, the Koreans, and the Japanese have smaller chests.

TABLE 9.—*Play of chest of Cantonese students.*

Expansion.	Students aged 20.	Students aged 21.	Students aged 22.	Students aged 23.	Students aged 24.	Students aged 25.	Students aged 26.
cm.							
2			1				
3	2	2					
4	6	2	2			1	
5	9	5	1	1	1		
6	16	8	3	1	1		1
7	9	5	3	1			
8	8	1	1	1			
9	1	1	1	1			
10	1	1	1				
11			1				
12							
13	1						
14							
15							
16							
17			1				
Totals	53	25	15	5	2	1	1

Expansion.	Students aged 27.	Students aged 28.	Students aged 29.	Students aged 30.	Students aged 31.	Students aged 36.	Students of all ages.
cm.							
2							1
3							4
4	1		1		1		14
5							17
6					1		31
7						1	19
8							11
9				1			5
10							3
11							1
12							
13							1
14							
15							
16							
17							1
Totals	1		1	1	2	1	108

Generally speaking, people with large chests have greater chest expansion and, where the chest measurement is greater, the height is not correspondingly increased. These chest measurements are not so much a question of race as of occupation and physical development of members of a given race.

205355—7

CONCLUSIONS

1. The Chinese people average 165 centimeters in height. The people living south of the Yangtze River, in general, are shorter in stature than those north of this river. For Cantonese students of 20 years or over, the average height is 163.6 centimeters.

2. The weight of the Chinese averages 56.9 kilograms in the north and 52.6 kilograms in the south. For Cantonese students of 20 years and over, the average is 51.9 kilograms.

3. Taking the weight-for-height index as a criterion, the index is found to vary from about 313 in the south to 384 in the soldiers of the north. For Cantonese students, it averages 317. These figures are much smaller than the averages for Americans and Europeans.

4. The chest circumference of Chinese is relatively small, varying from 77.4 to 86.9 centimeters. For the students in South China, the average circumference of the chest during rest is 78.9 centimeters, and they have a play of chest of about 6 centimeters.

The South Chinese are therefore inferior to their northern brothers in height, weight, and chest measurements. The Mongolian tribes of the far north and the peoples of Indo-China to the south are inferior in size to the South Chinese. Because of the great tendency of the Cantonese people to travel and their intermarriage with the Malay peoples, it can be assumed that this admixture has had much to do with producing a smaller race of Chinese. On the other hand, it has been my observation that they are capable of developing almost the same degree of muscular energy and physical endurance as are the larger races of mankind.

REFERENCES

1. BRETON, M. Bull. de la Soc. d'Anthrop. III 2 (1879) 592–597.
2. CROOK, A. H. Nature. London 78 (1908) 607.
3. DENIKER, J. The Races of Man. Chas. Scribner's Sons, New York (1904) 282.
4. DENIKER, J. The Races of Man. Chas. Scribner's Sons, New York (1904) 382.
5. GAUP, H. Verlauf-Bericht über anthropologische Untersuchungen an Chinesen und Mandschuren in Peking. Zeitschr. f. Ethn. 41: 730–734.
6. GIRARD, H. Notes sur les Chinois du Quangsi. L'Anthropologie 9 (1898) 144–170.
7. HAGEN, B. Ueber Körpergrösse und Wachstumsverhältnisse der Südchinesen. Verlag. en Mededeelingen der Konink. Akad. van Wettenschap. Afd. Nat. 2e. Reeds. Deel 20 (1884) 236.

8. HAGEN, B. Anthropologische Studien aus Insulinde. Verh. Konink. Akad. van Wetenschap. **28** (1890).
9. HAGEN, B. Typical Heads and Faces of Eastern Asiatic and Melanesian Peoples. Stuttgart (1907).
10. HRDLIČKA, A. Remains in Eastern Asia of the race that peopled America. Smiths. Misc. Coll. No. 16, **60** (1912) 4.
11. HRDLIČKA, A. The races of Russia. Smiths. Misc. Coll. No. 11, **69** (1919) 15.
12. HUTCHESON, A. C. China Med. Journ. **34** (1920) Anat. Sup. 16.
13. INDO. Tabelle der Körpermessungen an Versicherten der Meiji Lebensversicherungsgesellschaft (1894) (quoted by Koganei).
14. IVANOVSKY, A. Zur Anthropologie der Mongolen. Archiv. f. Anthrop. **24** (1897) 65–90.
15. IVANOVSKY, A. The People of the World. Izvestia Imp. Soc. Friends Nat. Sci. etc. (1911) Moskow, 121, Anthropol. Sec. 27. (In Russian.)
16. KOGANEI, Y. Beiträge zur physischen Anthropologie der Aino. II. Untersuchungen an Lebenden. Mitt. Med. Fac. Kais. Japan. Univ. **2** (1893–1894) 251.
17. KOGANEI, Y. Messungen an Chinesischen Soldaten. Mitt. Med. Fac. Universität, Tokyo **6** (1903–1905) 123–145.
18. KOIKE. Keirin Iji (1887) 165 (German translation by R. Mori). Zwei Jahre in Korea. Internat. Archiv. f. Ethnogr. **4** (1891).
19. LEGENDRE, A. F. Bull. Mém. Soc. Anthrop. VI **2** (1911) 77 and 520.
20. LEGENDRE, A. F. Bull. Mem. Soc. Anthrop. VI **2** (1911) 102.
21. MARTIN, R. Lehrbuch der Anthropologie. Gustav Fischer, Jena (1914).
22. McCAY, D. Sci. Mem. Gov't of India (1908) Calcutta.
23. MERRINS, E. M. China Med. Journ. **24** (1910) 318.
24. MISAWA, T. Pedagogical Seminary, Worcester **16** (1909) 104.
25. MIWA. Altersbestimmung durch Körperlänge und Kopfumfang (Japanese) Kokka Igaku Kwai Zasshi, No. 172 (1901) (quoted by Koganei).
26. QUETELET, L. A. J. L'Anthropométrie. J. Ballière et Fils, Paris (1871).
27. SHOEMAKER, A. China Med. Journ. **27** (1913) 362.
28. SHOEMAKER, A. Quoted by Whyte, China Med. Journ. **32** (1918) 325.
29. STEIN, A. Notes on Physical Anthropology of Chinese Turkestan and the Pamirs. Serindia III. Appendix C 1382.
30. TALKO-HRYNCEWICZ, J. DE. Notes on Anthropology of Chinese of the North (in Russian) (1899) Moskow.
31. TOPINARD, P. L'Anthropologie. Schleicher Frères, Paris (1910).
32. WEISBACH, A. Reise der österreichischen Fregatte "Novara." Vienna (1867).
33. WILFORD, E. C. China Med. Journ. **35** (1921) 190.
34. WHYTE, G. D. Journ. Roy. Anthrop. Inst. **41** (1911) 278.
35. WHYTE, G. D. China Med. Journ. **32** (1918) 210.

INDEX

[New generic and specific names and new combinations are printed in **clarendon**; synonyms and names of species incidentally mentioned in the text are printed in *italic*.]

N

O

O

CONTENTS

The Philippine Journal of Science is issued twelve times a year. The sections were discontinued with the completion of Volume XIII (1918).

Yearly subscription, beginning with Volume XIV, 5 dollars United States currency. Single numbers, 50 cents each.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Library, Bureau of Science, Manila, P. I.

Subscriptions may be sent to the BUSINESS MANAGER, Philippine Journal of Science, Bureau of Science, Manila, P. I., or to any of the agents listed on the third page of this cover.

Entered at the post office at Manila, P. I., as second-class matter.